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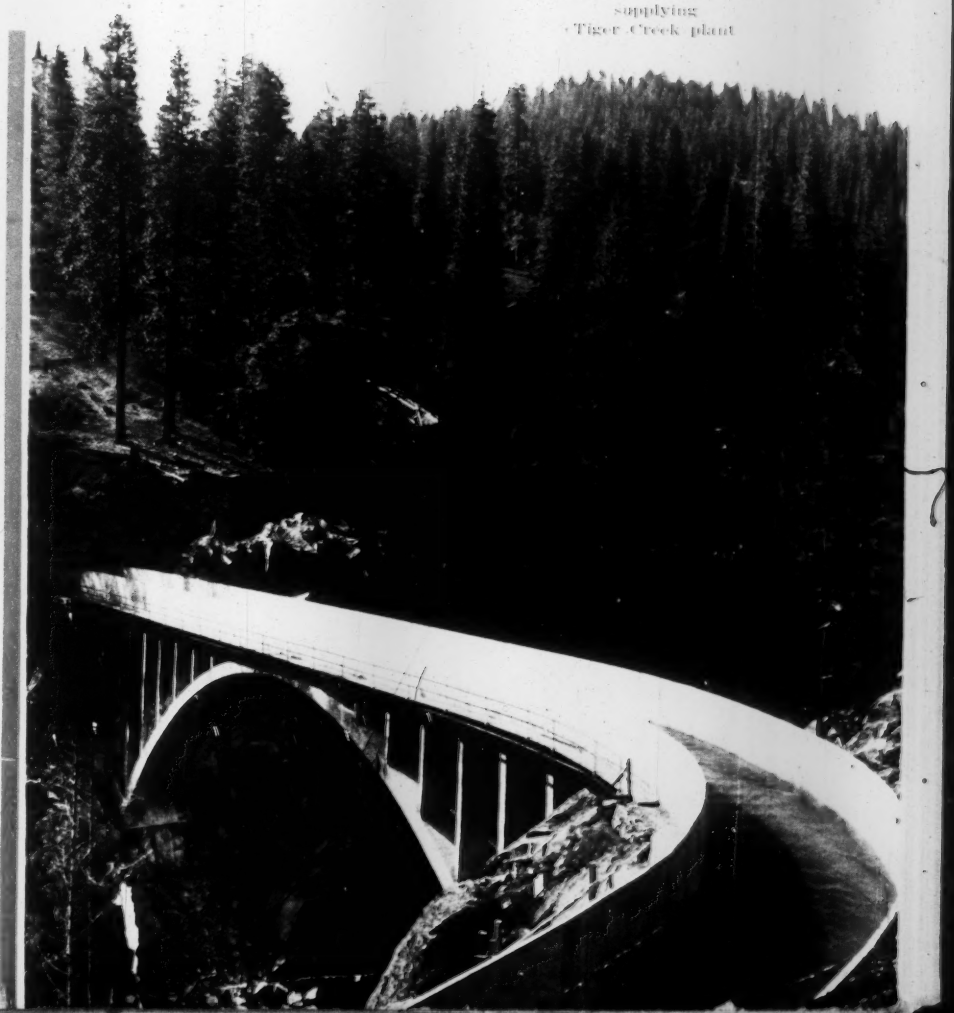
Reinforced-concrete flume supplying Tiger Creek plant



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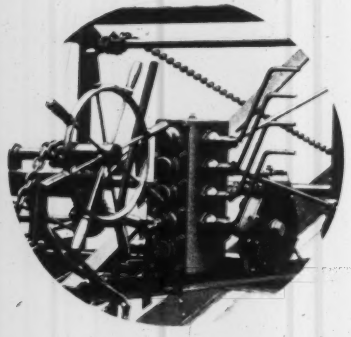

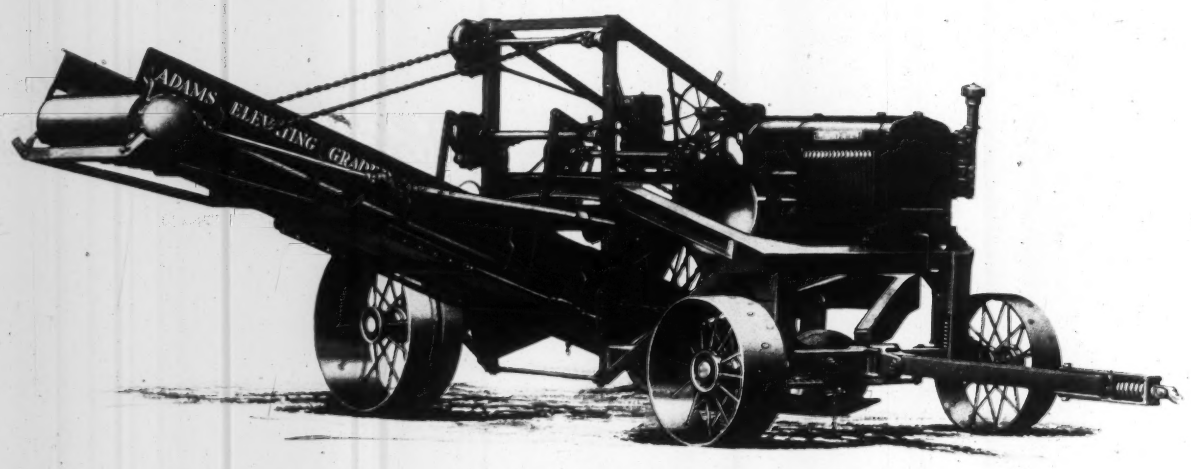

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F. E. Schmitt, Editor

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Signs of Spring

INDICATIONS of bettered financial conditions have become more noticeable since last week's issue, and good judges now look on them as real signs of spring—so far as money can make good times. Continuing rise of the bond market, large reduction in the number of bank failures from the high figure of January, a much better feeling in railroad circles following the loan of more than fifty millions by the Reconstruction Finance Corporation to the roads in most immediate need, are among the evidences of financial convalescence and growing confidence in the future. The measures taken at Washington to rehabilitate credit are showing some effect, and if not neutralized by increased unemployment and the resulting further decline in purchasing power they are bound to continue their work of thawing out frozen funds and assets. With further improvement in the status of bonds it may be expected that municipal securities will progressively gain in the favor of investors. The important thing now is to maintain municipal public-works activities unimpaired.

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Labor Guarantees Bonds

THE ingenious closed-circuit financial arrangement of banks-to-city-to-employees-to-banks payment for construction evolved by San Francisco to carry on the Hetch Hetchy construction program, as outlined in our news pages last week, provides a highly suggestive solution for one of the current financial emergencies. Its chief result is the preservation of 1,300 jobs at this critical time. In brief, the plan permits the city to sell its bonds at par to pay wages; the banks advance the necessary funds as payment for the bonds, and as wage payments are made the funds move to the workers through their own syndicate, established for the purpose, which withholds 10 per cent of the total to provide safety for the banks. Thus the workers take up the slack in the circuit in return for the assurance of a job. The plan presents possibilities that are not unworthy of general consideration in these times of municipal inability to solve public-works problems.

Toll-Bridge Successes

GRATIFYING news is contained in a statement of the New York Port Authority on its toll bridge operation. Even the latest structure, the great Fort Lee Bridge, is showing a large income despite bad times and winter traffic, while the Arthur Kill bridges, hitherto poor earners, are beginning to produce returns. These experiences give excellent testimony in favor of works carefully planned and ably and efficiently built—which is true in exceptional degree of the Port Authority's bridge structures. They also lend new support to the toll-refunding plan of building large bridges. Since this plan has been adopted or is being considered in many parts of the country, proof of its value is timely and significant. It might also be added that those private toll bridges that have enjoyed outstandingly careful planning and efficient construction have shown similarly notable results, as particularly exemplified by the Tacony-Palmyra bridge at Philadelphia.

Is Engineering Local?

ACCORDING to a resolution of the Western Society of Engineers it is desirable that in appointing engineers for the design of public buildings local men be selected. The resolution bears on the recent demand of architects that the design of post offices and other federal buildings be intrusted to local architects, a demand that finds justification in the many local factors involved in the architect's work. There does not appear to be such reason for the employment of local engineers, however. Steel or concrete design is little affected by geographical factors. Foundations, it is true, involve local knowledge more definitely, yet even in this department there are well-known instances of better service by engineers not of local experience. We grant that it is desirable to make opportunity for work by local engineers—for their sake; but only a demonstrable advantage to the public can support a demand to this effect by a professional body.

Definite Wage Regulation

IN ITS first year of operation, the Bacon-Davis prevailing-wage act has proved confusing and unsatisfactory. Its chief fault lies in the fact that contractors are forced to bid blindly as to rates of wages they will be required to pay, despite their greatest care in predetermining these rates. An added weakness is the lack of specific penalty for violation of the act, other than implied cancellation of the contract. The President's enforcement proclamation of two months ago did nothing to clear up the indefinite status of the act. To correct the inherent faults of the present law, Senator Metcalf has introduced in Congress an amendment that will make it much more satisfactory, besides extending it to day-

labor projects. The amendment proposes that wages to be paid must be stipulated in the advertisement for bids, and that if necessary periodical wage adjustments and corresponding adjustments of contract payments are to be made during the life of the work. Definite penalties are also provided. These changes will make the law workable, and the amendment therefore deserves support in fairness to both contractor and worker.

A Conservation Plan for Iowa

ENGINEERS and engineering bulk large in the 25-year plan and program of conservation that Iowa has now under survey through a board of conservation and the state fish and game commission. Elaborate studies have been made to collect and place on maps and charts all the data that can be secured on the state's geology, geography, topography, hydrology, soil and its uses, surface and underground waters, wooded areas, erosion and silting, condition of streams and lakes, wild life and fish, scenic, historic and scientific points of interest, population trends, trends in land values, climatology, land drainage, recreation facilities and many other subjects. Every phase, said Jacob L. Crane, consultant to the conservation board, in addressing the recent meeting of the Iowa Engineering Society, involves engineering study and engineering judgment. Mr. Crane has enlisted the assistance of engineers and the engineering societies in the study he outlined. The friendliness of engineers to the plan and their willingness to cooperate are in sharp contrast to the bitter controversies of a few years ago, when the Izaak Walton League was at odds with engineers over the Winneshiek Bottoms Drainage District and other like projects. Properly conceived, most public planning projects have extensive engineering import; cooperation is therefore logical and constructive.

Limits to Engineering Practice

A CLEAN-CUT case of an engineer qualified by training to practice engineering but unlicensed in the state where he was practicing has been decided against the engineer. The point at issue is one which has given concern to proponents of license laws ever since licensing was first proposed, and one which until now has been purposely avoided in most states. In the few cases of license law violation that have gone to court heretofore the issue has centered on incompetence. The case in point is one brought by the state of New York against Domenico Briganti, a civil engineer educated at an Italian university. He was charged with practicing engineering and (through use of the term civil engineer on his letterhead) holding himself out as able to practice, without being licensed to practice. In defense of the use of the title civil engineer Mr. Briganti claimed that he had a right to such use because of the degree conferred upon him. This view was rejected by the court. It held that use of the title is in direct violation of the law; that if permitted it would lead to needless confusion. While this decision is from an inferior court it serves as a clear indication that an engineer, regardless of his qualifications, may not with impunity continue to practice engineering in states where license laws are in effect, nor may he use titles tending to give the impression that he is licensed to practice. More important still, the decision makes it clear that the unqualified man cannot circumvent the law by avoiding the direct use of the descriptive term (in this case "professional engineer") used in the law to describe the man licensed to practice under its provisions.

Concrete Research and the Future

MODERN concrete design represents one of the most notable examples of a research-built art. Since the early days of this century, when a few pioneers perceived the possibilities of the new art, many engineers have devoted time, money and thought to unraveling its intricacies. Roads to new truths opened out in every direction. Many were explored to their end with profit, but on others the investigators encountered barriers that have resisted repeated battering.

A particularly promising year of investigation was reviewed at last week's meeting of the American Concrete Institute. The remarkable new vistas into the realm of concrete design that were revealed indicate that business depression has not retarded mental growth. New and important knowledge of masonry walls, concrete columns and arches presents a challenge to the practical designer that he cannot ignore.

Fundamentally, so far as columns and arches are concerned the new knowledge concerns that most baffling property, plastic flow. Consider the reinforced-concrete column. One of the basic principles of current design practice is the assumption of a constant ratio of steel stress to concrete stress. Yet study of columns under sustained working loads shows that this ratio changes rapidly, being increased four or five times within a year by redistribution of load between concrete and steel. As the concrete unloads onto the steel, the familiar ratio n ceases to have meaning. Vertical steel reinforcing becomes an important compression element. Spirals are twice as effective as the vertical steel in assuring load-carrying ability.

These are definite conclusions. Taken by themselves they might imply that the safety of existing concrete structures is merely a happy circumstance. But they are supplemented by the additional fact that no difference was found between the total load-carrying capacity of loaded and unloaded columns regardless of the load redistribution between the concrete and the steel. Engineers have long recognized the adjustability of reinforced concrete as well as of structural steel and have counted heavily upon it, without being able to evaluate it. There is now some promise that in reinforced concrete the phenomenon of plastic flow is emerging as a measurable quantity.

In arch analysis, too, we find new concepts built around a recognition of plastic flow—adjustability under load—and an attempt to measure shrinkage and temperature effects. The problem is complicated by lack of field data, but the concrete arch committee makes a bold theoretical analysis that if substantiated would exert profound effect on practice. Here again we find acceptance of the unloading of stress onto the steel as the central action in the adjustment.

If the plasticity theory can be verified and limiting values of temperature and shrinkage effects determined, arches can be built longer and lighter than those now conceived as purely elastic structures. If plastic flow reduces concrete stress as much as claimed, the Freyssinet method of inducing compensating strains in an arch during construction may be so much waste effort, as the committee implies. On the other hand, the Freyssinet method has to its credit several notable structures whose success is unquestioned, while the plastic-flow effect in an actual arch is still a matter of pure conjecture.

Concrete masonry walls, like concrete columns, have been the subject of extensive experimentation. Their structural behavior proved particularly gratifying, so far as compressive strength was concerned, depending in amount largely upon the strength of individual units and to some degree on type of mortar joint. Accepted working stresses of 70 and 80 lb. per sq.in. are too conservative if anything, as was also evidenced in fire-exposure tests, which most of the walls withstood with a high factor of safety. Flexure tests are still inconclusive, and lateral stability after fire exposure must be regarded with suspicion. Watertightness must be recognized as a product of good mortar and workmanship. Nevertheless, the tests indicate that good walls can be built and have been built, and provide the additional useful information that wallette (specimen) tests can be translated into data for actual wall-size panels by application of a factor of about 0.9.

All of these research results are tangible, workable and usable. They foreshadow extensive revision of some phases of concrete design. They promise economies, bolder structures, and structures in which doubtful stress conditions and values are reduced to a minimum. They offer evidence that research is the only sure way to progress, not only in the results actually obtained in the column and wall tests but in the absence of other research results that still seems to hinder concrete arch development.

Public Welfare and Public Works

PARALYSIS or continuance of local public-works construction remains the critical problem of the day. Since it involves the essentials of urban existence, the question touches everyone's personal well-being and comfort. But present conditions make the issue immediate. Municipal construction, employing more than a million workers, is the decisive factor in the fight to rebuild confidence, employment and economic health. The fight may be lost if these workers are turned out to join the army of the unemployed.

To justify the demand for stopping public improvements it is asserted that municipal works are excessive and their costs too high. What are the facts? A correct understanding of the situation is vital, for many thoughtful men have joined in the outcry against taxes, bond issues and construction.

Light is thrown on the situation by the second of our series of articles on the present municipal crisis, published in this issue. It presents an analysis of the scope and cost of municipal services, and shows that there is nothing mysterious about the large increase in improvements and taxes during the past few decades. Population growth, rising price levels and improved living standards made it inevitable. But not all of the increase is real; when reduced to a uniform price basis some of our services are found to have become cheaper rather than dearer.

Unfortunately the average city dweller is a Jekyll-and-Hyde character: a kindly and generous Dr. Jekyll with highly developed social feelings when public efforts are made to improve his city, but a ruthless and selfish Mr. Hyde when the tax bill comes in. Because hard times make taxes burdensome he now thinks of himself only as a taxpayer instead of as a beneficiary of municipal services. The foundation of the present ill favor with which public expenditures are viewed is the utter lack of appreciation by the city dweller of what he receives in return for taxes.

Most of the services that the community renders to its members are such as could not be provided individually. Others are of such social importance that they could not wisely be left to commercial exploitation. All have been found desirable and indeed essential. Their cost, when translated into figures that could be compared with other items in the householder's budget, appears not unreasonable. This is a brief statement of the net content of our present article.

Doubtless many economies can be made by improvement in efficiency—which is eminently desirable so long as essential functions are not crippled. But regardless of economies, if we look into the future of municipal costs we may conclude that the factors which have operated to increase costs in the past will have the same results in the future. Population growth continues. Living standards will not be lowered permanently, however much they have been forced down during the past two years. And it is not likely that our demand for services will decline; the trend is decidedly in the other direction. In short, our urban civilization will continue to develop in complexity, and after the present storm subsides our city programs of construction and reconstruction will unquestionably be continued with renewed vigor.

In the long run, then, curtailment of public works can be attained only through abandonment of present standards and a return to the habits of primitive days—wholly improbable events. But what about the possibility of curtailment now, this year, to cut down city expenditures and reduce taxes? That is the urgent question of the day, for many cities, finding a horizontal slash of all departments impracticable, have made a vertical cut by stopping improvements.

Here we face a question that goes beyond the needs of the city itself and touches the heart of today's economic problem. It is universally agreed that public works are the prime bulwark of stability in times when private business is depressed. For this reason the use of public works construction to balance industrial ups and downs has been the most talked-of feature of revival efforts during the last two years. Today, however, the relation between public works and employment is even more impressive. With nearly ten million unemployed, the addition of another million or more would threaten disaster. Were we to reduce public business to the level of private business the strain on the economic machine might be multiplied to the point of collapse.

In the past six months the progress of local improvements has been checked all over the country, as money could not be found, due to the strangulation of banking and investment. The threat of increased idleness has become worse since the first of the year, however. Public-works budgets have been cut indiscriminately, and the discharge of thousands of engineering planners foreshadows the idleness of a hundred or a thousand times as many workers this summer. Dangerous overload may thereby be placed on the country's revival efforts.

These are the facts that must be considered in thinking about postponement of public construction today. They speak forcefully in favor of continuing our current construction programs undiminished. Municipal economizing may well be in order, but the present is not the time to consider it. Every citizen and primarily every engineer who ponders the facts will, we believe, find them to constitute a compelling argument against stopping public works.

Developing Water Power on the Mokelumne River

Salt Springs rockfill dam provides main storage resulting in 171,000 kva. of power installation in series of five plants—Concrete flume 21 miles long conveys water to main Tiger Creek plant — Program permits rehabilitation of historic old Electra plant

FULL ADVANTAGE of the power possibilities of any river can be obtained only through a program of development that can be carried forward over a period of years in such a way that new power units may be brought into service progressively as required without undue increase in the investments at any one time. Such a program for the development of the Mokelumne River in California has been in progress for some time. The most recent additions to it are the Salt Springs reservoir, with its 328-ft. high rockfill dam and the Salt Springs and Tiger Creek power houses. This article reviews the entire project and outlines what has been accomplished and what remains to be done. —EDITOR.

THE MOKELUMNE RIVER hydro-electric development program, now under construction by the Pacific Gas & Electric Co., is the most important program of its kind to be completed in California for several years. Two plants, with 71,000-kva. total capacity, are now in operation, and construction on the remainder of the program is scheduled for completion in 1934. Recent advances in steam-power production in the state have resulted in extensive curtailment of hydro-electric programs, which makes the present development more notable. Its most outstanding feature is the record-breaking Salt Springs rockfill dam, 328 ft. high, which stores 130,000 acre-ft. of water and makes possible the complete economic regulation of the stream. The dam has been previously described in *Engineering News-Record*, and the following description outlines the principal features of the development program.

History—The Mokelumne River in central California was one of the first streams developed during the early mining period, and its waters were in use as early as 1857. From that date some of the flow has been in use continuously for mining, irrigation, domestic water supply and hydro-electric projects. In 1902 one of the pioneer California hydro-electric and high-voltage transmission systems was inaugurated on this stream with the completion of the 28,000-hp. development at the Electra plant. The power was transmitted to the San Francisco Bay region over a 60,000-kv. line, and the system has been in service since that time. During this early development the storage on the river consisted of several small reservoirs on the headwaters (Fig. 1 which had a total capacity of abou 28,000 acre-ft. and were entirely i adequate to provide control of th river for proper utilization.

Beginning in 1923 an intensive stud of the stream and its hydrology wa made by the engineers of the Pacifi Gas & Electric Co. The hydrographs in dicated that if storage capacity o 200,000 acre-ft. could be obtained, th river was capable of being develope to produce 1,000,000,000 kw.-hr. an nually. Such a system would use prac tically the entire flow of the river and its tributaries down to the elevation of the Pardee reservoir (storage for the domestic supply for the East Bay Municipal Utility District) through a series of five hydro-electric plants, including a complete rehabilitation of the old Electra plant and an increase of its installed capacity to 60,000 kva. This entire program is shown in plan and profile on the accompanying map.

Actual construction work was begun in 1928. At the present time the principal units, including the Salt Springs dam, Salt Springs power plant, conduit line to Tiger Creek plant and the Tiger Creek power plant have been completed and are in operation. The remaining features of the program in the order of development are: (1) reconstruction of the Electra plant; (2) installation of the 15,000-kva. West Point plant between Tiger Creek and Electra; and (3) diversion of the Bear River flow through tunnel to the Salt Springs plant, whence it will flow through the lower plants.

Salt Springs Dam—The main storage is provided by the Salt Springs dam (Fig. 2), a rockfill structure 328 ft.

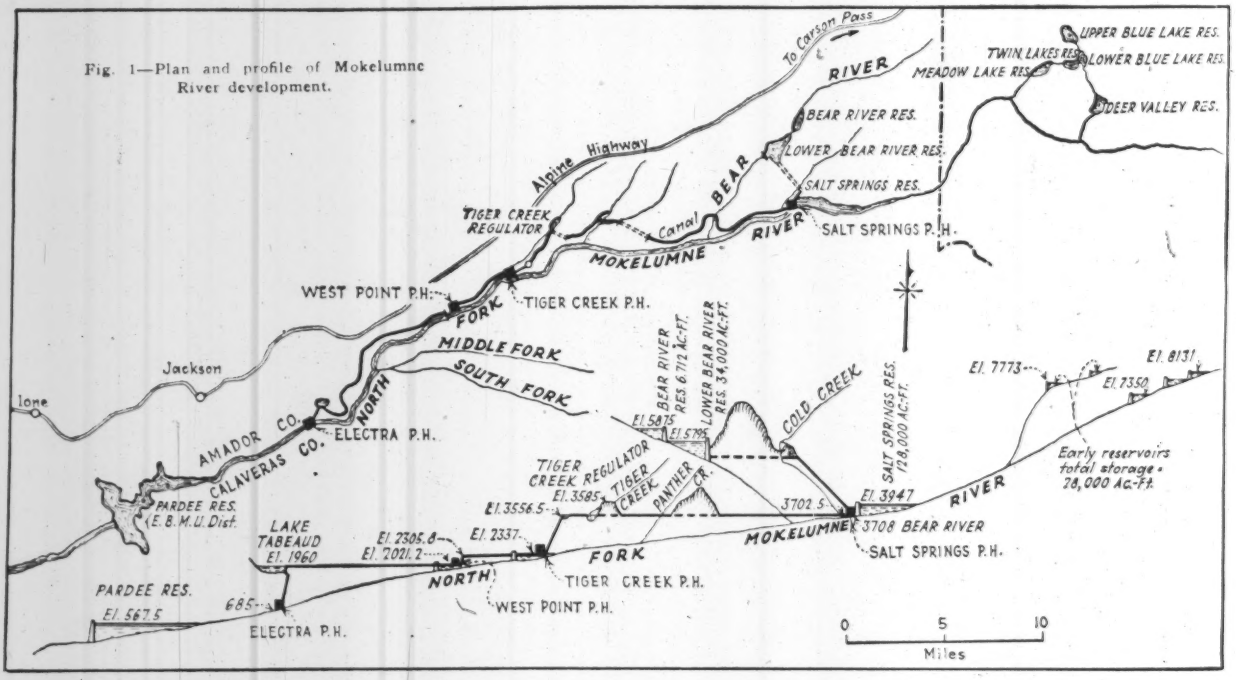


Fig. 1—Plan and profile of Mokelumne River development.

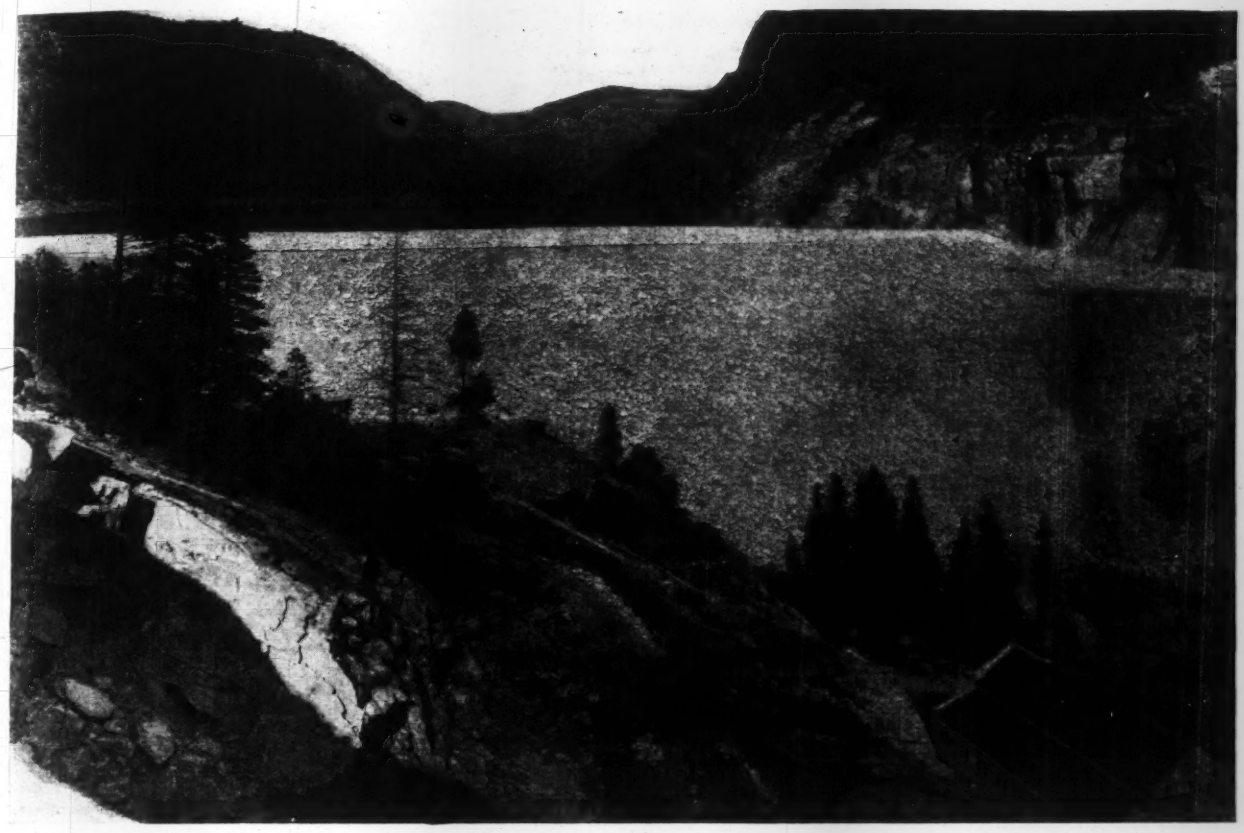


Fig. 2—Salt Springs rockfill dam, 328 ft. high, provides main storage of 130,000 acre-ft. Power plant using head in reservoir is shown in lower right corner.

high, 1,300 ft. long at the crest, containing 3,000,000 cu.yd. of rock. The reservoir has a capacity of 130,000 acre-ft. This structure has been previously described in *Engineering News-Record* in detail as follows: design, Jan. 16, 1930, p. 92; construction procedure, Aug. 28, 1930, p. 332; and special crawler-mounted dump trailers, Oct. 17, 1929, p. 616. The dam was completed in March, 1931, and the reservoir was filled to within 27 ft. of the top that spring.

Conduit and regulation

Discharge from the Salt Springs reservoir passes through (or bypasses) the Salt Springs power house, located immediately at the base of the dam. From there the discharge or bypassed supply flows directly into the Tiger Creek conduit for conveyance 21 miles to the forebay above Tiger Creek power house. With the exception of 2½ miles of tunnel and two steel siphons, the entire conduit consists of a concrete flume of 550 and 625 sec.-ft. capacity located mainly on excavated bench; the larger size at the lower end extends from the regulating reservoir to the forebay. Several of the intermediate streams are directed into the conduit.

Design and construction of the concrete flume were based on a thorough study of engineering and economic conditions. A flume type of construction was considered best from factors of hydraulic flow and the resulting loss of head and water in the length of line. Comparison of the timber-flume to the ordinary type of concrete-flume construction showed that the annual cost of the latter type exceeded that for wooden construction. However, the engineering preference was in favor of concrete, and studies were made to improve the method of concrete-flume construction to reduce its cost. The length of the line and its uniform size permitted the economic use of special equipment that effected material reduction in costs. Use of steel panel forms, moved and set by motorized handling equipment and mobile concreting plants, characterized the construction layout.

The flume is 7 ft. high by 14 ft. 3 in. wide and follows a falling contour (0.8 ft. per 1,000 ft.) around the side of the mountain.

On the bench cut, excavated with power shovels, graded and rolled, the forms were laid for transverse concrete ties on 4½-ft. centers. These concrete ties were poured some time before the following construction and provided a foundation for a timber roadway for material trucks and the rails for the concreting equipment.

Following the setting of the floor and wall reinforcing steel, the first major piece of equipment, a form-setting jumbo, self-propelled on an 8-ft. 4-in. track gage, advanced and set the steel forms into position. This jumbo was of steel frame with clearance to permit equipment and tractors to pass underneath.

Following this piece of equipment was the concreting jumbo, moving on the same rails and carrying the mixer and belt conveyors. Aggregate trains of tractor and trailers transported batched material from proportioning plant to the mixer. The trailers dumped individually into the mixer

DATA ON MOKELUMNE DEVELOPMENT POWER PLANTS

Plant	Maximum Static Head	Flow, Sec.-Ft. Maximum Average Diversion	Flow, Sec.-Ft. Peak Flow of P.H.	Installation, Kva.	Estimated Output Million* Kw.-Hr.	Estimated Output Peak, Kw.
Salt Spring	244.5	550	550	11,000	34.3	6,000†
Bear River	2,089.0	130	160	25,000	125.6	21,000
Tiger Creek	1,218.6	550	625	60,000	321.1	51,000
West Point	284.6	575	575	15,000	89.2	12,000
Electra	1,265.0	575	650	60,000	342.6	54,000
Total				171,000	912.8	144,000

* Average year.
† Summer peak; Winter peak, zero.

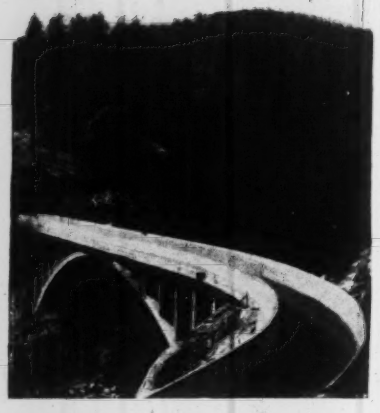


Fig. 3—Crossing intermediate creeks by concrete arches, as shown, or by steel siphons, the conduit to the Tiger Creek plant consists of 18½ miles of reinforced-concrete flume 7 ft. high and 14 ft. wide and 2½ miles of tunnel.

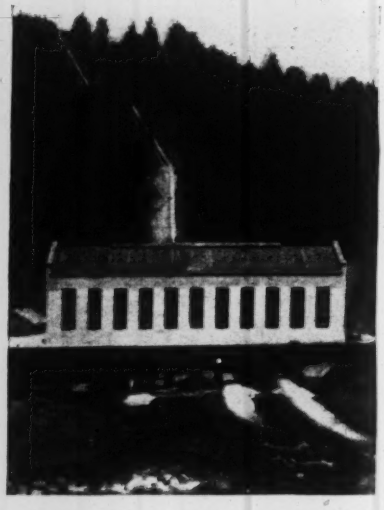


Fig. 4—Tiger Creek plant, principal new power unit on the river development, has a 60,000-kva. installation and a 1,219-ft. static head. The old flume is not part of the present project and will be removed.

hopper, while the tractor ran beneath this machine and was elevated and turned around by a separate tractor-hoisting jumbo and placed at the head of the train of empties for the return trip. Concreting was done in 60-ft. sections by three passings of the concrete jumbo.

Two days after pouring, the wall forms were removed by another jumbo equipped with motor-operated hoist, and the forms were loaded onto trailers for moving ahead. Following removal of the forms the walls were covered with burlap and kept moist for two weeks. Four complete form-handling and concreting units were used during the construction, and each averaged 160 ft. of flume per day. Incidental structures on the conduit include two concrete-arch aqueducts (Fig. 3), many structures carrying the flume across small gulches, and two 93-in.-diameter steel siphons.

About 2½ miles above the forebay for the Tiger Creek plant a regulating reservoir formed by a buttress-and-slab type concrete dam 100 ft. high was constructed on the Tiger Creek watershed to impound the flow of that stream and to control the flow in the conduit. This reservoir provides 175 acre-ft. of live-storage capacity, which is sufficient to allow peaking of the Tiger Creek plant for about 20 hours if full diversion is being made at the head of the conduit. From the outlet of this regulator the concrete flume continues with 625 sec.-ft. capacity and a width increased to 14 ft. 7 in. to the forebay at the head of the penstock. The forebay is an artificial basin made by excavating about 200,000 cu.yd. of material from the ridge above the power house. The sides and bottom of this excavation were covered with 2 in. of gunite. Storage capacity of 40 acre-ft. is sufficient to peak the plant for 30 min., or about the time required for water released from the regulator to arrive at the forebay.

Power plants

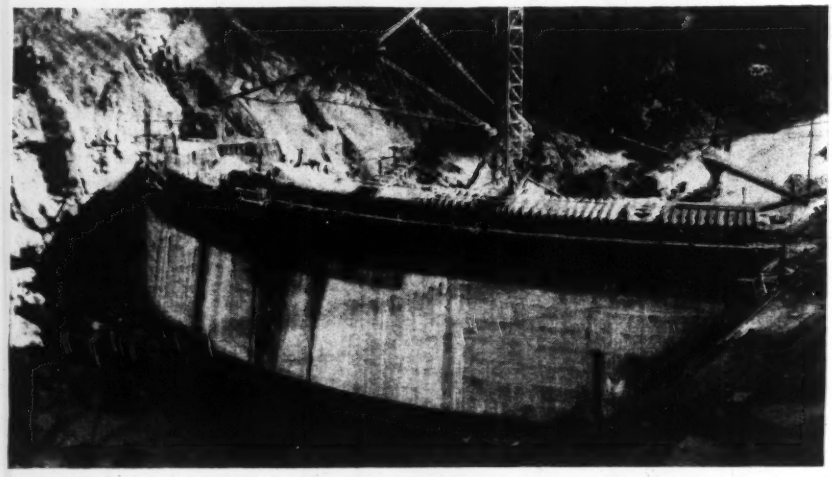
The uppermost plant on the system located immediately below the Salt Springs dam will utilize the withdrawal from that reservoir, which produces a maximum static head of 244 ft. In addition, a future diversion from the Bear River will be brought into the Mokelumne canyon through a tunnel and will be delivered to this power house under a static head of 2,104 ft. This constitutes a separate power drop on the system, although housed in the Salt Springs plant. The variation in head between these two supplies makes necessary the installation of separate units. A vertical-reaction turbine of 11,000-kva. capacity, handling 560 sec.-ft., is now in operation, using the water released from the Salt Springs reservoir. The installa for the higher-head unit will be impulse machine of 25,000 kva. capa ity. When the second supply is into this plant, it will be possible accommodate wide variations in out by regulating the two flows.

The water supply for the Tiger Cre plant is conveyed from the foreb through a single steel penstock (Fig. 4 4,750 ft. long, 102 in. in diameter at t top and 72 in. in diameter at the w at the power house. The upper 4,000 is riveted pipe with a thickness varyin from $\frac{5}{16}$ to 1½ in.; the lower 750 ft. of forged seamless steel tubing $1\frac{7}{8}$-in. maximum thickness. This li is supported above ground on concre piers with necessary anchors and ex pansion joints.

The penstock branches first into tw 54-in. diameter lines, which, in tur branch into two 36-in. pipes, each lead ing to an impulse waterwheel unit rate at 9,000 hp. Each of the two units o double overhung type operate a 30,00 kva. generator. Static head on th plant is 1,220 ft., with a net effectiv head of 1,190 ft. The plant operate with a maximum average flow o 550 sec.-ft. and has a peak capacity o 625 sec.-ft.

Design of the impulse units includes the latest refinements in this field. Straight-flow needle nozzles provide minimum disturbance of water flow; and the governing mechanism is operated to permit slow closure on load rejection to provide for water conservation. A jet deflector surrounds the jets and is connected with the governor to operate for the instantaneous removal of the jets from the wheel for load reduction. This jet deflector, in combination with the slow-closing needles, all operated by the governing mechanism, makes possible the unloading of the wheel without disturbing the conditions of flow in the penstock. This, in turn, largely elim-

Fig. 5—Tiger Creek plant afterbay dam, 2 miles below plant, is diversion point for lower developments.



inates conditions of surge in the line and made possible a cost reduction in the penstock and the elimination of a surge chamber.

Status of the project

Coordination of construction activity was an important feature of the main storage and Tiger Creek power units. Well-timed completion put these and the Salt Springs power plant in full operation in the summer of 1931. Work is going forward on the other units of the ultimate program.

Reconstruction of the Electra power plant and its conduit system is first. Present operation of this plant involves the use of two conduits taking water from the river ¼ mile above and 2 miles below the present Tiger Creek plant. Each of these conduits has forebay storage. Construction of a new conduit from Tiger Creek plant discharge to Electra at the highest possible elevation would have involved trouble from debris getting into the lower conduits and, more serious, did not provide a site for forebay storage. For these reasons the program calls for building a new conduit, from the high-water level of the existing forebay on the lower of the conduits now in use, on a rising grade until it reaches the river. This point is about 6 miles below the Tiger Creek plant and requires about 13 miles of conduit. Operation of the existing conduits is not interfered with by this work. This conduit work and the modernizing of the plant will complete the reconstruction program for the Electra development.

The intermediate West Point plant will be constructed just above the diversion point of this new conduit. Its water supply will be conveyed by another new conduit about 4½ miles long, which will extend upstream to the afterbay dam (Fig. 5) of the Tiger Creek plant. The West Point plant will be a 15,000-kva. installation with a 284.6-ft. static head. When this plant is completed, the fall of the river will be utilized from the surface of the Salt Springs reservoir (El. 3,947) to the outlet of the Electra plant (El. 685).

The remaining development on the upstream section will be an additional reservoir on Bear River to supplement the existing 6,000 acre-ft. of storage. A tunnel and penstock will carry this flow into the Salt Springs power house. A further provision on this development is the diversion of the flow from Cold Creek into the Bear River supply.

Organization

The Mokelumne River power development was planned and built by the engineering and construction forces of the Pacific Gas & Electric Co. A. H. Markwart is vice-president in charge of engineering. I. C. Steele, chief of the division of civil engineering, and his assistant, Walter Dreyer, were in charge of civil engineering design. J. P. Jollyman, chief of the division of hydro-electric and transmission engineering, assisted by E. A. Crellin, was in charge of electrical design. C. C. Green was field engineer. O. W. Peterson, engineer of general construction, was in charge of all construction operations and was assisted by P. I. Kurtz, superintendent of the Salt Springs division, G. M. Werhle, superintendent Tiger Creek division, and J. E. Cooney, assistant superintendent. R. D. Reeve was resident engineer on Salt Springs dam.

Creosoted Piles Good as New After 13 to 21 Years' Use

Building foundations show long life of treated piles — City building codes should distinguish between treated and untreated piles

EXCELLENT endurance of old creosoted piles used as foundations for building was reported by Frank R. Judd, engineer of buildings, Illinois Central R.R., at the annual convention of the American Wood Preservers Association. Piles driven in 1911 for a turntable foundation at Campaign, Ill., in a sandy clay alternately wet and dry, depending upon rainfall, were exposed for examination in October, 1931, by digging around them. As stated by Mr. Judd:

"The piles looked as if they had just been driven. Borings showed that both the untreated heart and the outer treated portion were apparently as sound as new piles. The borings also showed a treatment penetration of 2½ in. and gave off a strong odor of creosote, while when placed in a paper container they gave off sufficient oil to soak into and discolor the container. These piles had been in the ground 21 years with apparently no deterioration, indicating that a creosoted pile thoroughly surrounded by soil and covered with a concrete cap to prevent volatilization of the oil will have a long, if not a permanent, life."

Similar piles of platform shelter foundations at Memphis, driven in 1914 and exposed on Nov. 4, 1931, showed about 4 in. penetration, with both creosoted and white wood in good condition, as determined by borings taken about 2 ft. below the concrete footing. These piles, on track-elevation work, were in a sand fill alternately wet and dry, as there are no sewers and rainwater from the downspouts of the shed is discharged into the sand fill.

For a 300-ton coaling station on the bank of the Mississippi, built in 1917, where there is a 40-ft. variation in water level, the lowest point of the foundation was 20 ft. above low-water line. Creosoted piles were used at a considerable saving in cost as compared with carrying the foundations down to low water and using untreated piles. On examination in December, 1931, both the treated and the untreated parts were found to be sound, with a creosote penetration of 1¼ to 2 in. The treated borings had a strong odor of creosote, while the heart borings had a marked odor of resin, indicating that the creosoted shell was protecting the center core of the pile.

Creosoted pile foundations for a 150-ft. chimney at Fulton, Ky., built in 1919, were examined in November, 1931, and proved to be sound. The penetration was 4 to 5 in.; borings had a strong odor of creosote.

In contrast to these records, the case was cited of a timber grain elevator built on the bank of the Chicago River. A few years ago it was found to be leaning toward the river and this was supposed to be due to a movement of the earth and foundation. But examination showed that it resulted from rotting of about 6 in. of the tops of the untreated piles. It was necessary to expose the entire foundation on that side of the building, cut off the tops of the piles and underpin the structure with concrete, at a cost of about $30,000. It is assumed that the original builders did not make sufficient allowance for the range of rise and fall of the water level.

City building codes usually make no distinction between treated and untreated piles. In Chicago, for instance, all timber piles must be cut off at 1 ft. below city datum, or lake level. As a result untreated piles are used. With a different allowance for treated piles, a reduced depth of concrete foundation would be practicable for some types of buildings. This is done at New Orleans, where treated piles are required to be cut off only below the ground surface, while untreated piles must be cut off not less than 8 ft. below curb level or below the inverts of adjacent sewers. Mr. Judd suggested that these facts be considered in the preparation or revision of codes which now make no provision for the use of treated timber and piles.

Blasting to Settle Swamp Fills Approaches Rational Practice

Thorough sounding and soil surveys essential— Depth and character of swamp soil and nature of fill material influence blasting procedure

VERY SUBSTANTIAL PROGRESS has been made in the technique of blasting as a means of sinking embankments of stable materials through soft and semi-fluid swamp soils. Beginning with the rather hit-or-miss procedure of early practice, it has been learned that depth of fill, the character of both the swamp soil and embankment material and the blast-hole arrangement, explosive charge and order of firing have a direct influence on the stability and cost of the fill prism. Engineering processes are required to determine these factors and evaluate their influence. As these processes come to prevail, a science and art of fill settlement by blasting is developing, the effectiveness of which the roadbuilder can appraise with some degree of exactness in planning his highway location and grading. An expression of the new thinking is given in the excerpts that follow from a notable paper by M. W. Torkelson, acting state highway engineer of Wisconsin, read at the most recent convention of the American Road Builders' Association. —EDITOR.

IN DEALING with swamp-fill settlement by blasting, it is essential to know with certainty the depth of the unstable material—the distance down to a solid foundation. When the fill has settled it is again necessary to know that the embankment has been brought all the way down through the unstable muck to the solid bottom.

These facts cannot be determined by a sounding rod because a sounding rod can be pushed down easily through some soils such as sand or marl, which have ample supporting power to carry the superimposed embankment. Also, a sounding rod, when withdrawn, does not bring with it any reliable indication of the nature of the soil encountered. Even an earth auger is likely to bring up false samples. There must be special apparatus for the purpose.

The essential feature of such an apparatus is a bit, by means of which a true sample of the material encountered at any depth may be brought to the surface for examination. It must be driven by mechanical devices that will permit rapid withdrawal of the bit so that not too much time and expense will be involved in the exploratory operation. The drill should be mounted in such a manner as to be moved easily from place to place.

During the past season in Wisconsin successful use has been made of a machine shown by Fig. 1. This is a loading machine as well as a sounding machine; that is, after having drilled the holes necessary for sounding and sampling, it is available for drilling the holes for blasting operations. By means of this machine, soundings may be made and samples of the subsoil secured to show accurately soil profiles and cross-sections of the swamp to be dealt with. Such a profile is shown by Fig. 2. By means of the profiles and cross-sections it is possible to estimate with considerable accuracy the amount of material that must be hauled in and placed to provide a stable embankment, and also to estimate the approximate quantity of explosives necessary to remove the muck and settle the stable material.

The location and number of charges and the amount of explosive in each charge depend on the depth or the amount of unstable material to be displaced and on the quantity of overburden in place at the time the charges are fired. As yet we do not know the exact relation, nor do we know that this is capable of exact determination. Decision at present must be left to the judgment of the man in charge.

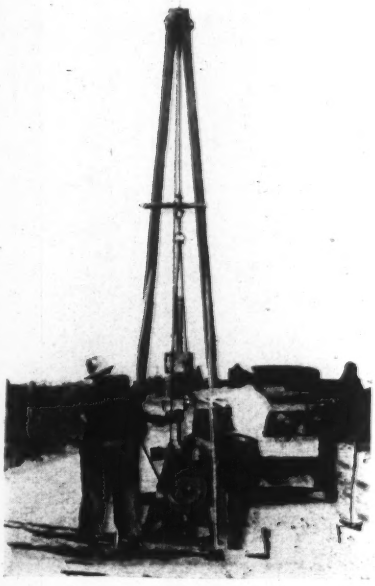


Fig. 1—Sounding and loading machine, with crew of three men, takes samples and gives depths of swamp soil and drills blast holes.

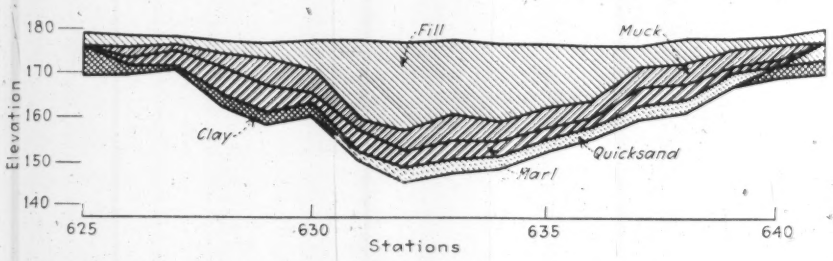


Fig. 2—Actual swamp-soil profile determined by sounding machine (Fig. 1) and afterward blasted to settle fill.

Fig. 4 is a loading pattern that was used successfully with fill material consisting of fairly dry sand. The first loads were placed along the center line and fired in a series of several, the number being determined by local conditions and the judgment of the operator.

Another plan of loading that produced satisfactory results is shown by Fig. 5. It will be noted that there are four loads spaced 10 ft. at right angles to the center line of the highway. Spaced 15 ft. away, along the highway, a row of three charges is placed, staggered with the first. These seven charges, constituting a unit, are all fired simultaneously. It is possible to fire one or more of these units, but care must be taken to have each unit complete before being fired.

There are two parts to the handling of any swamp-shooting project. The first is the design of the shots. This includes making the preliminary soundings, placing the overburden, the determination of the spacing and the amount of explosives in the charges, and the

Fig. 3—A well-executed blast, showing fill lifted vertically and underlying muck being blown out laterally to each side.

selection of the proper kind of explosive to be used. The second is the actual work of loading and firing the shot.

The design of the shots is a technical engineering problem to be determined like any other of the multitudinous design problems arising in every state highway program. Because the various factors involved in a swamp-shooting problem are not capable of as exact determination and evaluation in the light of our present knowledge as is, for example, bridge design, it is not proved that skilled supervision is not possible. In fact, the uncertainty involved is such that the problem demands a very high type of skill and judgment.

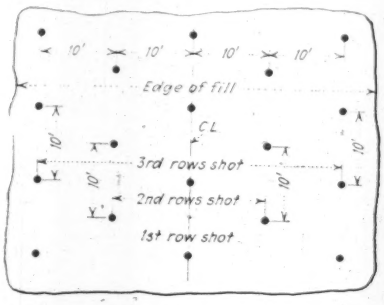


Fig. 4—Loading diagram for a sand fill that does not bridge or arch in settling.

The actual placing and firing of the explosive requires men of a very special type. Such men also are developed through study and experience, but their job is to carry out the determination of the engineer. They must, nevertheless, have a thorough understanding of the characteristics of the various types of explosives to be used and must especially be familiar with safety rules and practices.

It is necessary for every state highway department that has marsh and swamp problems to develop skilled operators, who should be supervised by men of greater experience and possessed with that more mature judgment that is necessary in a supervisory capacity. There should be a study of marsh and swamp problems before the year's work is undertaken, and suitable arrangements should be made to carry out the blasting so that it will be most effective and will afford the minimum of interference with the regular grading operations. This task Wisconsin is trying to carry out for the 1932 season.

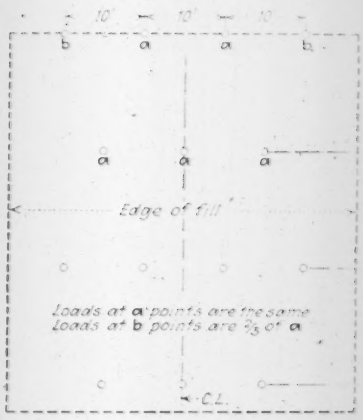


Fig. 5—Loading diagram for a fill of material that may bridge or arch in settling.

Roadbed Covered With Cotton Sheets Before Surfacing

AN EXPERIMENTAL ROAD in which cotton cloth is used to stabilize a light bituminous surfacing has been constructed near Gonzales, Tex., by the Texas state highway department.

The base of the road consists of a crushed-flint-clay gravel placed 10 in. thick loose. According to S. C. McCarty, division engineer in charge of the work, this base was thoroughly shaped and rolled until the cross-section desired was obtained. It was then opened to traffic for 30 days. Every effort was made to bring the grade to the proper cross-section, and all depressions were brought to grade with asphalt patches. All loose particles were removed with a revolving broom, and hand brooms were used to remove foreign substances that escaped the revolving broom. Great care was taken to clean thoroughly the entire width of the road to be treated, and sweeping was continued until all the dust or loose dirt was removed before applying the prime course of light tar. It is claimed that this requirement must be met in order to obtain a satisfactory road.

The prime coat of 0.3 gal. per square yard of light tar of 8 to 13 viscosity was applied with a regular asphalt distributor. The tar was heated to 140 deg. F. Further experiments were made on a short section with 250 penetration asphalt as a primer, and when applying the top course it was noticed that the fabric has less tendency to stick to the wheels of the distributor on the asphalt primer. The fabric was also better secured to the asphalt primer. After seventeen hours a cotton fabric was spread longitudinally along the entire surface of the road treatment; 2½ in. was allowed for laps. The cotton fabric weighs 3 oz. per yard 38 in. wide and costs 8½c. per yard.

About 0.5 gal. per square yard of 250-penetration asphalt was then applied to the fabric. This asphalt was heated to 240 deg. F. and applied with an asphalt distributor. Immediately after, the surface was covered with ¼-in. to ½-in. crushed-limestone cover material at the rate of 1 cu.yd. to 40 sq.yd. of road surface. After being leveled and shaped with a hand broom and broom drag until a smooth surface was obtained, it was rolled with a 5-ton roller. When this covering had been applied and rolled the road was opened.

It is too early yet, according to Mr. McCarty, to say whether or not the cotton used in this piece of experimental work was worth its cost, or to give any facts as to whether maintenance costs are greater or less than those on any other stretch of ordinary asphalt road.

Cotton fabric spread longitudinally with 3½-in. laps on an experimental road near Gonzales, Tex.

A view of the finished highway in which cotton fabric was used as a binding material.

Screened Aggregate Reduces Cost of Subgrade Stabilization

Experiments on South Carolina highways indicate 50 per cent cut in haulage charges for screened aggregate and effect on earth subgrade equal to pit-run material

STABILIZING local natural-soil road-base materials with washed gravel, crushed stone or crushed slag, instead of pit-run gravel, holds promise of large savings in freight charges and handling costs. Soils in many sections of the country in which coarse materials are scarce contain the right quantity and quality of sand and clay to make a good road base when a limited amount of stabilizing material is added to them. The common practice of using pit-run gravel for this purpose means paying freight and handling charges on sand and clay that already are available in the local soil. The experiments described in the following article indicate savings of from 40 to 55 per cent in freight and handling by using stabilizing materials free of sand and clay. Where rail hauls are long, these figures are impressive. —EDITOR.

EXPERIMENTS to determine the economy and effectiveness of washed and screened gravel, crushed stone and crushed slag for stabilizing highway subgrade prior to the application of bituminous surface treatment made by the South Carolina state highway department during the last two seasons indicate that equally good results may be obtained in this manner as when pit-run gravel is used in strengthening local soils. The savings in freight and handling charges range from 40 to 55 per cent, as compared with those that obtain when pit-run gravel is employed, due to the smaller amounts required.

Sand, clay and other binder materials occur in sufficient quantities in practically all soils of South Carolina on which surface treatment is contemplated. There is a wide range, however, in the percentage of them in different localities. There also is some doubt whether the grading and character of the local sand, silt and clay are as good as those qualities of selected pit-run gravel. Hence, the soil to be stabilized is in every case carefully analyzed to determine the quantity and size of the added material needed to give the right mixture.

The first step in stabilizing a stretch of subgrade is to prepare a natural or artificial sand-clay base. The stabilizing materials are then delivered from the railroad cars to the base in trucks. The amount applied has ranged all the way from 50 to 200 lb. to the square yard. Spreading is done either by hand from stock piles along the side of the road or directly from the trucks by means of spreader boxes.

With the stabilizing material evenly distributed to the right depth, it is scarified into the surface of the base to a depth of 2 to 4 in. and then thoroughly harrowed to mix it with the loosened base material. Traffic is allowed to compact the mixture well before the surface treatment is added.

While it seems too soon to draw definite conclusions, the results to date indicate that where the local soil contains sand, clay and other binders of the proper size and quality, a base stabilized in the manner outlined is as good as or better than one on which pit-run gravel has been used. The base secured appears to be equal to one resulting from the application of 1 to 4 in. of pit-run gravel, depending on local conditions and the amount of stabilizing material added. Several sections stabilized in this general manner in September, 1930, have stood up as well as adjacent sections on which the usual amounts of pit-run gravel were used to prepare the subgrade.

Charles H. Moorefield, state highway engineer of South Carolina, and W. K. Beckham, maintenance engineer, both point out that the work done to date has been entirely experimental but has given sufficiently gratifying results to warrant having undertaken the experiment.

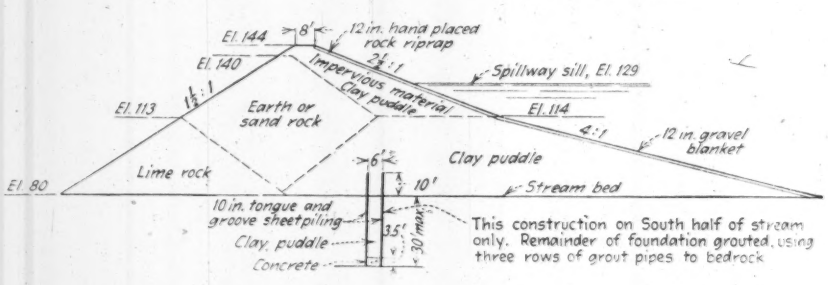
Minor Repairs Restore Usefulness of Earth Dam in Arizona

Neglected dam of irrigation concern now in state ownership—New earth placed, tunnel lined, gates repaired and spillway enlarged

REPAIR of the Lyman Dam, an earth structure for irrigation in Arizona, and enlargement of its spillway to insure against overtopping of the dam have been carried out recently by the state highway department. This dam, built in 1913 by private interests for the Lyman irrigation project of 15,000 acres, is on the Little Colorado River, some 10 miles above St. Johns, Ariz. During a heavy storm on April 14, 1915, the dam failed as a result of rapid filling of the reservoir against a comparatively new earth embankment. As reported in *Engineering News* of April 22, 1915, p. 794, it was rebuilt by its owners, as a large tract of farm land was dependent upon the reservoir water supply, which had a capacity of 7½ billion gallons (23,000 acre-ft.).

As rebuilt, the dam was 800 ft. long with a maximum height of 65 ft., as shown in the accompanying drawing. Water for irrigation was drawn off through a concrete-lined horseshoe tunnel 7½ ft. high and 8½ ft. wide, the flow being controlled by slide gates in a tower on the upstream side of the dam. There has been continued leakage into the tunnel and at the gates, with consequent heavy loss of water. Furthermore, the spillway channel had not been completed to full section, owing to shortage of funds. Examination of the dam in 1929 under W. W. Lane, then state engineer, showed that repairs were needed for the safety of the dam and protection of people and property below it. But no funds were available at that time.

In 1930, however, most of the land of the Lyman project came into the ownership of the state of Arizona. The construction of the dam had been carried on largely by funds obtained by the farmers through the state loan board, which took as security a lien against their lands. Water has been low in the reservoir since 1922, and in consequence the farmers were unable to



Lyman Dam, Arizona, as rebuilt in 1921 after washout. Repaired recently under state supervision.

make the payments, so that in 1930 the state foreclosed on approximately 90 per cent of the land. Since then some of this land has been leased to the original owners. Under these conditions care of the dam became the direct charge of the state, and the legislature appropriated $19,800 for the repairs. Difficulties encountered delayed the work, but it was finished in December, 1931.

Settlement along the crest had reached a maximum of 3 ft., which was considered as an indication of some movement in the base or foundation. For this reason it was thought inadvisable to increase the foundation pressure by raising the water level. The crest was therefore raised only about 10 in. to a uniform level. It was necessary to add earth on the downstream slope in order to maintain the original crest width of 8 ft. and to fill gullies that had been washed by rain. The crest was plowed and wetted, and the new material was moistened before placing and then rolled to form a compact mass. No preparation of the downstream slope was necessary. Borings were not made, since it was evident from a careful examination that the dam was a well-compacted fill and that its foundation had not undergone material changes.

From the accompanying drawing it will be seen that the upstream portion of the dam consists of clay puddle. An excellent grade of impervious clay was available near the site, and the small amount of leakage through the dam indicates that the material was properly placed. Since the state engineers began inspection of the dam, leakage has been noticed at both abutments and a small amount at the center. That at the right end is thought to come through the interstices between the rocks, as well as along the contact plane between the earthfill and the rock abutment. The quantity is small and has never been considered serious. Leakage at the left abutment came from a spring that was covered by the lower portion of the dam. Since the toe of the dam is composed of lime rock, as shown, it gives water free escape to the stream channel below the dam. Leakage that appears near the center of the structure at streambed may come through the dam or through foundation material, but the quantity is too small to endanger the dam. As leakage, together with a spring at the south end of the downstream side, has kept the ground wet for some distance, about 1,000 ft. of 8-in. corrugated and perforated metal pipe has been laid at depths of 5 to 8 ft., the drains converging to a 12-in. pipe that discharges into the river channel about 650 ft. below the dam.

The maximum recorded flood at St. Johns, 10 miles below the dam, is 1,640 sec.-ft., but little weight can be given to this, as floodflow records are available for only a few years. The maximum probable flood was determined largely from a study of the drainage area and rainfall records. As an added factor of safety a freeboard of 5 ft. above maximum flood level was provided by the reconstruction. This freeboard was not necessary for wave action, but it was considered essential in view of poor flood records.

As the spillway capacity was only 33 per cent of the maximum expected flood, it was widened to full capacity. There are no gates or other structures in the spillway channel. Lining of the outlet tunnel with gunite effectually stopped leakage through the concrete. The eight slide gates, 2x7 ft., were operated by 2½-in. vertical shafts about 50 ft. long, but the supports were so far apart that all the shafts had become badly bent and it was difficult to operate the gates. As a result there has been continual waste of water. Defects in the shafts have now been remedied.

All this work has been done, partly by contract and partly by state forces, under the direction of T. S. O'Connell, state engineer, and J. A. Fraps, engineer in charge of dams.

Wear Experiences in Storm Sewers Having Heavy Scour

SMALL joints and resistant mortar between No. 2 vitrified paving bricks (shale) used in the lower third of certain steep storm sewers in Birmingham, Ala., make a combination that has successfully withstood velocities of 17 to 22 ft. per second since 1901. The runoff water contains considerable chert, gravel and surface washings from unpaved streets maintained with hard flint particles, which intensifies the scour. The pavers were laid in 1901 in 500 ft. of an existing 4-ft. sewer which had been built of clay brick, classed as hard-burned building brick, laid with hydraulic cement 1:3 mortar in the wide joints. A. J. Hawkins, city engineer, and M. Nicholson, drainage engineer, Birmingham, recited details of the city's experience with these high velocity sewers before the recent meeting of the National Paving Brick Association.

In 1901 an inspection of the sewer (its date of construction was not given) indicated that the lower third of the inner ring was in bad condition due to erosion. In places the bricks as well as the mortar joints were scoured away entirely, in others the joints stood up in ribs ½ to 1 in. above the bricks.

Thirty years after the relined portion had been placed the joints on a curve were found scoured out ½ to ¾ in. below the original surface, but the brick was not affected except on upstream corners and ends. At a second point examined, where a 36-in. branch entered with a velocity of 14 f.p.s. at an angle of 30 deg., the main sewer having a velocity of 20 f.p.s., some ends and edges were scoured perceptibly. Above and below the branch entrance the bricks had not worn, but all joints were scoured from ¼ to ¾ in., the deeper scouring always occurring in the wider joints. At a third point, on a sharp curve, where the velocity was 22 f.p.s., the invert was in bad shape and the lowest line of brick was scoured 1 in. or more in depth, while the two adjoining rows were scoured badly on the edges and upstream ends. Joints were scoured 2 in. or more. The invert in this curve was badly laid, with irregular joints varying from nothing to 1 in. in width. Warped and crooked brick were laid unevenly and surfaced with mortar.

Another sewer, 4½ ft. in diameter, built at the same time under the same contract, where the velocity is 23 f.p.s., was found in perfect condition. The invert was an excellent piece of work with close joints and properly shaped brick laid to a perfectly even surface.

In the last 30 years many miles of sewer with vitrified brick inverts have been built in Birmingham with grades ranging from 0.2 to 10 per cent and sizes from 2½ to 8 ft. in diameter. Velocities range from 5 to 25 f.p.s. All sewers carry gravel and hard siliceous particles from the chert and slag surfaces and natural cherty clay formations, which means heavy scour. Because of this fact the vitrified brick inverts are used.

Traffic Counts in Indiana

Traffic counts in Indiana at 81 stations indicate that the heaviest burden on any road in the state is Indianapolis Boulevard in Hammond, where in a 24-hour period 31,680 vehicles were recorded on an average weekday and 41,150 vehicles on Sunday. On the same highway west of Michigan City the weekday average was 11,966 vehicles and on Sunday 17,770. The diagonal route, state road 67, between Indianapolis, Anderson and Muncie toward Fort Wayne is the heaviest traveled road out of Indianapolis, with 5,348 vehicles in an average weekday and 9,278 on Sunday. The counts were made last season by the highway commission, the Chicago Regional Planning Association, the Federal corn borer stations and Lake County.

Floor Placed First in Erecting Large Steel Arch

In building 547-ft.-span bridge over Merrimack River north of Lowell, Mass., the floor steel was laid on timber falsework and the arch trusses then erected, utilizing the hangers as posts

REVERSING the usual method of erecting a steel-arch bridge as two cantilever arms from which the floor is later hung, the erectors of the Tyngsborough bridge over the Merrimack River north of Lowell, Mass., elected to place the floor first, on timber falsework, and then to build up the arch on this foundation. The scheme worked very successfully, the bridge (the largest yet built by the Massachusetts department of public works) being placed in service on Nov. 11, 1931, after an erection period of four months, from the time the first pile was driven until the arch was swung. Such an erection procedure, requiring continuous falsework from shore to shore for such a long period, could be possible only in a stream not generally subject to sudden floods and substantially free from driftwood. The Merrimack is such a stream, and, in addition, it is maintained at a fairly uniform stage by means of numerous dams, one of which is only 6 miles below the bridge, at Lowell. Briefly, the erection procedure involved the following elements: driving timber-pile falsework, placing the floor steel entirely across the river, and then erecting the arch steel from either end, using the I-section hangers as temporary supports until closure was made at the center.

Design elements

The new Tyngsborough bridge replaces an old wrought-iron structure of four spans, completed in 1874 and now inadequate for modern loads. The old bridge was kept in service until the new bridge immediately upstream was completed. The new alignment provides a more direct approach to the bridge (the old approach being on a reverse curve) and a more efficient intersection layout with the Daniel Webster Highway, which parallels the river. Included in the approach to the arch is a concrete-incased rolled-girder span of 59 ft. over the tracks of the Boston & Maine Railroad.

The 547-ft. arch span is of the two-hinged braced type with two 20-ft. deep parabolic parallel-chord truss ribs of 34 panels. It has a rise of 96 ft. and involves 1,300 tons of steel. The trusses are spaced 34 ft. on centers to provide a 30-ft. roadway. A 6-ft. sidewalk is carried on brackets outside the downstream truss. Rolled 12-in. 36-lb. I-section hangers, connected top and bottom by 3½-in. diameter pins, carry the roadway between portal panel points 4 and 31. Beyond these portals at either end of the bridge the floor is supported directly on the arch trusses. At the portals where the wind loads are transferred from the top-chord lateral system to the bottom chord system, ingenious and simple floor-expansion joints have been utilized that function without interfering with the load transfer. This joint, illustrated in Fig. 2, is made up of three narrow flexible plates set in an X layout between the 24-in. floor beam attached to the wind chord and the adjacent 36-in. floor beam shoreward. End pins of the arch are 12 in. in diameter, and a 10-in. crown pin is used, placed on the center line between the arch truss chords. The west abutment is founded on outcropping ledge rock, and the east abutment on piles driven 30 ft. into hard strata underlying coarse sand and gravel.

Details of the bridge are simplified by an extensive use of rolled shapes. These find utilization in the hangers, floor beams, stringers, web members of the floor lateral system and web members of the arch trusses. Built-up chords, riveted in two panel lengths in the shop, are used in the trusses. Field rivets are 1 in. diameter, shop rivets ⅞ in.

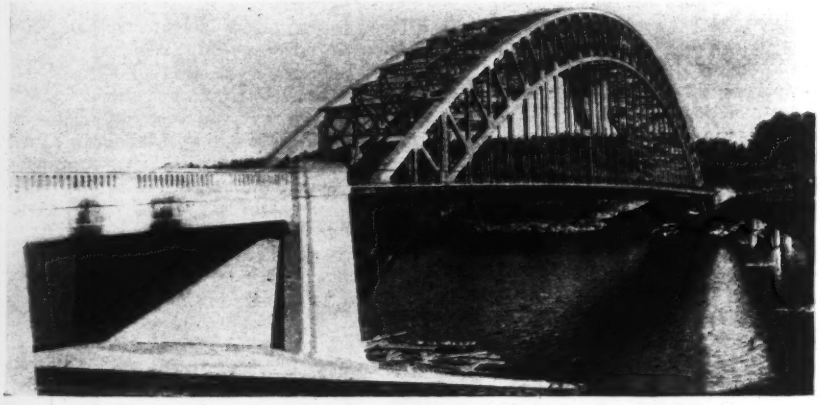


Fig. 1—Tyngsborough highway bridge, a 547-ft. steel arch, replaces old 1874 wrought-iron truss crossing (at right) of Merrimack River in Massachusetts.

Erection procedure

Erection was carried out with a single rail-mounted steam-powered traveler with a 90-ft. boom and a maximum capacity of 15 tons. A separate boiler was installed on the traveler for piledriving

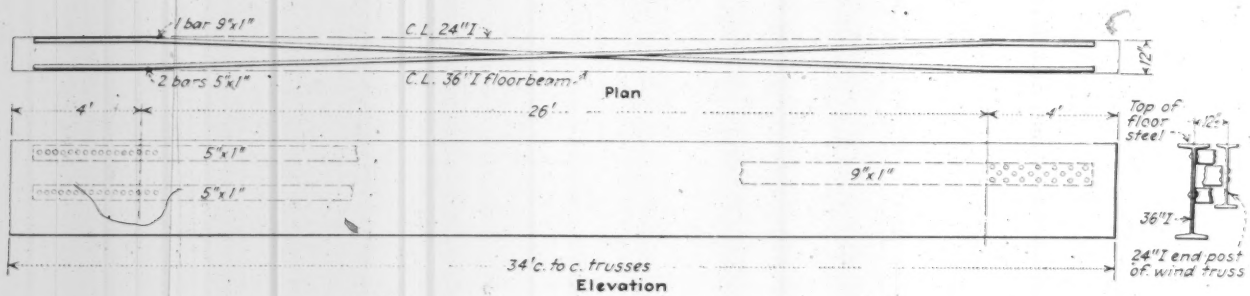


Fig. 2—Simple flexible-plate floor expansion joint used at both portals, designed not to interfere with wind load transfer from top to bottom chord lateral systems of arch trusses.

Fig. 3—Erecting a 547-ft. steel arch by assembling the floor steel on falsework and following with the erection of the arch trusses using hangers as posts. Horizontal timber struts between hangers are used to reduce their effective length during the time they act as columns.

service. The traveler moved itself by means of snubber lines from its hoist drums. Industrial railway cars that delivered the steel to the traveler from a yard at the east end of the bridge were also moved by means of lines from the traveler drums.

Erection began at the east end where falsework was driven, and three panels, including the floor and arch steel below the floor, were completed. The piling was then driven, and falsework and floor-steel erection continued progressively across the river, the floor steel serving as a platform for the erection traveler. Incidentally, the floor is 10 ft. higher at the west than at the east end, which presented a problem in building the falsework and in operating the traveler on the considerable grade. The maximum pile penetration was 38 ft., and the average 20 ft.; no difficulties were experienced with settling. Floor beams were placed directly over pile bents, supported on a system of wedges on the caps of the bents, as shown in Fig. 4. During erection the floor was kept wedged up higher than the final grades by amounts varying from zero at the pins to 6 in. at the center.

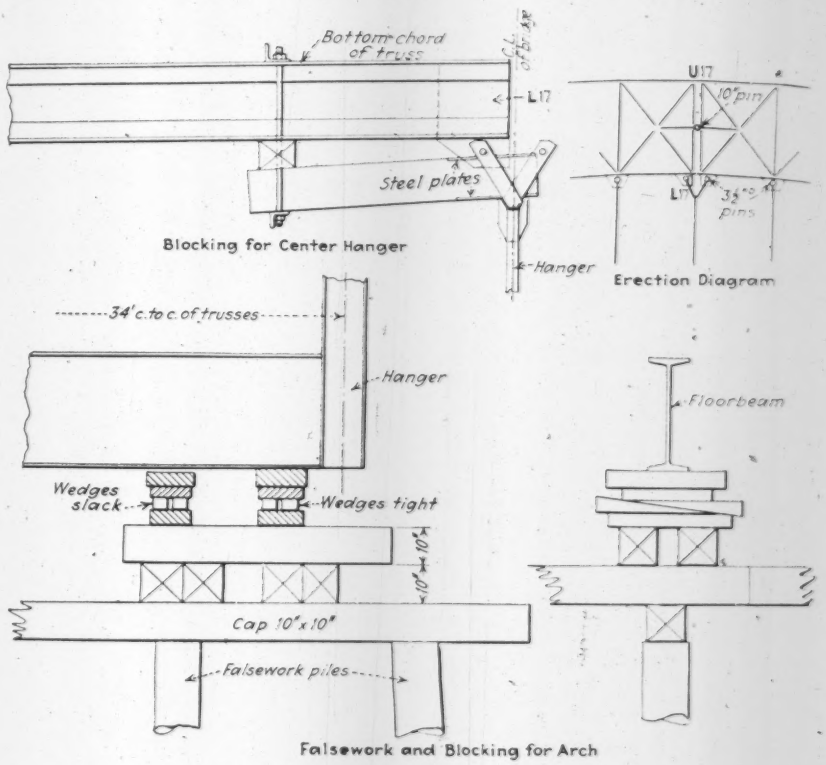
Arch-steel erection started at the west end, and with the traveler moving backward. With the still erected to the center of the span, the traveler was taken to the east end of the bridge, turned around and, again moving backward, erected the east half of the arch. The traveler was dismantled at the center of the span.

In erecting the arch the I-section hangers were utilized as columns to carry the steel trusses. This proved unusually effective and rapid. Some of the hangers could be used without bracing, but the effective length of the longer center hangers was reduced by timber struts formed by 3x8-in. planks either side of the hanger flanges, fastened together by rods and separators and placed about 25 ft. above the floor. The arch trusses were erected in two-panel lengths. Field-riveting of the arch was limited to the panels between the end pins and the portals, and to the floor, until all steel was erected. After that all arch members were riveted before they were lowered to bearing at the crown pin. Two panels of bracing at the center of the span were not riveted until after lowering, to provide for any lateral adjustment that might be necessary.

At the center the two halves were landed on 10-in. crown pins set on the center line of the trusses. This crown detail simplified the task of converting the three-hinged arch to a two-hinged type, but at the same time caused secondary stresses that were about 100 per cent of the primary stresses. As a consequence of these high stresses, the web members in the two center panels of the trusses are the heaviest web sections in the arch.

A special detail is used for the hanger at the center of the arch. This hanger is carried by two links, one connecting to each half of the arch.

Fig. 4—Special erection details included a system of blocking at the center of the arch truss, by which the center hanger could carry both halves of the truss before it was lowered onto the crown pin. Also a system of wedges beneath the floor beams, which in conjunction with 100-ton jacks at the panel points either side of the center permitted the arch to be swung clear of the falsework.



making the two halves alike in the shop and serving as an erection convenience since the hanger could support each half of the arch as it was erected. The joint was made rigid during erection by the device shown in Fig. 4.

Swinging the arch was accomplished by lowering the two halves simultaneously. First, the blocking under the odd-numbered panel points (1, 3, 5, etc.) was removed. The center panel points that would require the most lowering were supported by 100-ton jacks. The other loaded points (numbers 2, 4, 6, etc.) were each provided with two sets of blocking and wedges—one being driven tight and the other left loose. Lowering was then accomplished by splitting out the wedges and blocking in the two sets alternately. The work was begun at daylight and completed before noon, to avoid any difficulty from fall of the arch due to temperature after the center pins came to a bearing. Any irregularity of lowering was easily detected by the deflection of the hangers that supported the arch. Cutting out the blocking in this way was slow work, but it saved any expense for special rigging. The center of the arch was lowered about 6 in. before the crown pins came into full bearing. Although this center joint was observed three times daily after it was in bearing before it was riveted, friction on the pin apparently was great enough to keep it rigid, for no perceptible movement was noted in spite of a wide temperature range on one day.

With the arch swung and the floor concrete in place, the center splice plates were drilled and riveted, converting the span into a two-hinged arch for live loads. This splicing was postponed until there was no further probability of movement of the east abutment, which is on piles. In an emergency the splice plates can be cut off and replaced, using rivets in reamed or new holes.

Erecting the arch by the method adopted—that is, the floor first, followed by the arch ribs—made it possible to adjust the end pedestals after the steel was erected and just before the arch was lowered to a bearing. Thus it was not necessary to have any closing members made because of errors in setting the pedestals or variation in shop manufacture. The cast-steel pedestals were wedged up to the proper contact with the 12-in. pins and then grouted with antimonial lead.

The Tyngsborough bridge was fabricated and erected by the Boston Bridge Works, Cambridge, Mass., of which John C. Moses is chief engineer, H. M. Chadwick construction engineer, and Otto Palmunen superintendent. It was designed and erected under the supervision of the Massachusetts department of public works, Arthur W. Dean, chief engineer, and G. E. Harkness, bridge engineer. The general contractor was Simpson Bros. Corp., of Boston.

Decisions in Engineering Law

By Herbert Braasch
Attorney at Law, New York City

DECISIONS reached in cases tried in the higher federal courts and in the state supreme courts are summarized in these articles appearing from time to time in *Engineering News-Record*. —EDITOR.

Rules for Work Not Conforming to Specification

Defective materials and inferior workmanship entered into the general construction of a building in violation of specification requirements. The owner did not accept the work, refusing to make payment of a balance due under the contract because of shortcomings. When the contractor brought action for payment the question was raised as to what deductions should be made.

It was held that the measure of recovery to the contractor was the agreed contract price less money already paid him and minus the damages resulting from his failure to comply fully. Where defects in material, construction or workmanship are remediable without materially injuring or reconstructing any substantial portion of the building the owner is entitled to the expense of making the work conform to contractural requirements.

Where violations cannot be remedied without reconstruction of or material injury to a substantial portion of the building the measure of the owner's damage is the difference in its value as constructed and what its value would have been had it been built according to contract.—*Graham vs. Anderson, Nebraska.*

Injunction Against Union in Anticipation of Strike

Rissler Bros., heating and plumbing contractors, of Hackensack, N. J., sought a court order against the Plumbers & Steamfitters Union: (1) restraining the union from interfering with the contractor's undertakings; (2) ordering the union to supply the contractor with union help; (3) stop declaring the contractor unfair to union labor.

In support of this request the contractor claimed a steamfitter in its employ was ordered to stop work by the business agent of the union; that this business agent refused to furnish a union steamfitter to replace this journeyman on the ground the contractor had been declared to be unfair to union labor.

On behalf of the union its business agent denied by affidavit that the steamfitter in question had been called off the job; that there had been any interference with the contractor's business by the union; that there had been any refusal to furnish union mechanics or that the contractor had ever been declared unfair to union labor; also that the job referred to was practically finished and the steamfitter had not left the job at all and that the real cause of dispute was the fact that Henry P. Rissler, of the contracting firm, who was formerly a member of the plumbers' local, had been expelled for non-payment of dues and the union offered expressly to reinstate him upon his compliance with the constitution and bylaws of the union.

It is the general rule that such order as the contractor requested will not be given where, as in this case, the material facts on which the contractor's case depends are met by full, explicit and circumstantial denial under oath of the union's agents. Such injunction will not be granted merely to allay the fears and apprehensions of individuals, but they must show the court that the acts against which they ask protection are not only threatened but will in probability be committed to their injury.

The object of the preliminary injunction requested by the contractor is to prevent some threatening, irreparable injury pending a full and deliberate investigation of the case on its merits; it will not be ordered unless from the pressure of urgent necessity and where the damage threatened during the pendency of the suit is of irreparable character.—*Rissler vs. Plumbers' Local, etc.*—*New Jersey.*

Railway Survey East From the Mediterranean

Preliminary survey work has been completed for the proposed new Bagdad-Haifa Railroad, which will provide an easy land route between the eastern Mediterranean and northwest India. The new line will take five years to complete and will be 685 miles long, the route lying from Haifa in Palestine through the oases in Trans-Jordania and Iraq to Hit, on the River Euphrates, and thence through Fallujah to Bagdad. The project involves the construction of seven tunnels and ten viaducts for the steep ascent from the Jordan Valley, and also a 1,700-ft. bridge across the Euphrates near Hit. The work of the survey party was handicapped by climatic conditions and geographical obstacles. The temperature varies from 10 deg. F on the high desert plateau to 110 in the shade in the valley of the Jordan. The line rises in some places to a height of 3,000 ft. above sea level and falls in others as low as 830 ft. below sea level.

Steel Sheetpiling Carries Tunnel Through Fault Zone

Use of horizontal sheeting and extensive grouting successful in six months' fight to penetrate 50 ft. of soft ground in New York City aqueduct 500 ft. below surface—Emergency bulkhead saves tunnel from flooding

A SHIELD of steel sheetpiling driven horizontally, first for a top-center drift and later all around the perimeter of full-section enlargement (except the bottom segment) proved successful in carrying the New York water tunnel No. 2 through a short fault zone under Bronx River. Driving of the 21-ft. tunnel was interrupted for six months in the effort to progress 50 ft. through a heavy water-bearing section of disintegrated rock lying between formations of limestone and gneiss, material that, when once confined, developed a hydrostatic head of 250 lb. per sq.in. An elaborate grouting schedule requiring thousands of bags of cement preceding the driving of the sheeting checked the rush of mud and water into the tunnel. An emergency concrete bulkhead erected at the first sign of trouble later saved several miles of tunnel from being flooded and filled with mud.

Geology

The tunnel, extending for 20 miles from Hill View Reservoir in Yonkers to Fort Hamilton Park in Brooklyn, is being driven from nineteen shafts. For the most part it is a circular section with a diameter of 17 ft. inside the concrete lining, 21 ft. inside of rock. While the alignment is in a general north and south direction, the alignment swings to an east-west direction between shafts 2 and 3 in the Bronx, where the tunnel crosses under Bronx river. Borings taken along the route previous to letting the contract revealed disintegrated rock underlying the river valley and along the contact between the Inwood limestone on the south and east and Fordham gneiss on the north and west.

In driving the tunnel the geology of the river crossing was accurately determined. The fault was approached from the shaft 3 heading—that is, from the southeast side. About 4,400 ft. north of shaft 3 a large pegmatite dike obliterates the contact and lies between the limestone and the gneiss. The pegmatite was found to be completely decayed in place to a sandy clay containing harder loose remnants of original materials, many of which, while much softened, retained their original structure. At its east edge is a layer of yellow clay, 1 to 2 ft. thick, followed by thinner layers of greenish-yellow chlorite sand. East of this lies the limestone, which contains micaceous bands disintegrated to a brown sandy material, and the harder portions of the rock are much jointed.

Along its western edge the pegmatite dike is in direct contact with hard but blocky Fordham gneiss. It seems probable that the pegmatite lying between the two formations was subject to heavy faulting after intrusion and that its presence was the result of the existence of a former zone of weakness. The pegmatite, having been broken by faulting, then disintegrated under the influence of circulating groundwater. Other seams of pegmatite in the immediate vicinity and outside of the disturbed ground are entirely sound.

As the tunnel heading approached the fault zone from the east through the limestone, an increasingly heavy flow of water was encountered, most of which originated in the chlorite sand and in the jointed limestone. At the tunnel level the fault zone proper was but 50 ft. wide, though borings show it widens considerably toward the surface.

Borings gave warning

As preliminary borings had indicated poor ground underneath the river, the contractor was expecting some difficulty, but nothing like that was actually encountered. On July 11, 1931, the last advance was made in the regular tunneling procedure. For several days prior to that date the limestone had been showing signs of weakness and water was coming through the seams, so full-section steel timbering of steel ribs supporting pressed-steel liner plates had been placed as the excavation progressed. Because of previous experience in driving through a similar, but much less troublesome, fault under East River, in which an increased thickness of lining

Fig. 1—Steel piles driven as shields in New York water tunnel. View shows tunnel section after third stage of driving had been completed. The steel piles are supported by rings of 10-in. H-beams. Center posting is carrying needle beams used to support roof during second stage of driving.

was required, the tunnel section was enlarged to a 24-ft. diameter and the steel timbering was built to that size. The top heading and bench method was being used in driving, and the steel roof supports had been carried forward to the face of the heading. On July 15, in drilling a round in the face of the heading, considerable water was struck in the cut holes.

A concrete bulkhead was immediately placed across the heading at the face of the bench. On July 22 drilling with a 4-in. diamond drill was started through this bulkhead to attempt to shut off the water by grouting. When the first hole had been drilled 42 ft. another heavy flow of water was encountered. Drilling and grouting continued for some days, many of the holes reaching lengths of 60 to 85 ft. Finally, on Aug. 5, drilling was continued in the first hole to ascertain the exact nature of the material ahead. This hole went forward 195 ft., being carried far into the gneiss formation on the other side of the fault. A log of this test hole is shown in Fig. 2.

The extensive grouting in the heading had checked the flow of water to such an extent that the heading bulkhead was removed and excavation was resumed on Aug. 26. However, the character of the ground became so alarming that the contractor deemed it wise to place a concrete bulkhead, 11 ft. thick, back in the full-excavated section of the tunnel, thus preparing himself for any emergency. This foresight later proved to be of the utmost value. The bulkhead, completed Sept. 11, contained a 6x6-ft. muck opening in the bottom and a 3x5-ft. manway in the top. Both openings were protected by steel doors placed on the heading side of the bulkhead. Drain and grout pipes were placed through the concrete in case of need.

Work was again resumed in the heading. About 20 ft. of progress had been made when ground conditions required the placing of another concrete bulkhead at the face of the advanced heading to permit additional grouting to be done ahead. Upon the completion of this grouting a hole was blown through the last bulkhead, and on Sept. 16 a timbered pilot drift was pushed ahead for purposes of investigation. A sandbag bulkhead was maintained near the face of this drift. Suddenly, on Oct. 6, an inrush of muddy water from the face of the pilot drift swept away the sand bags. The lower door of the main bulkhead was immediately closed. An increasing flow of water then taxed the capacity of the tunnel pumping equipment, and on the next day the upper bulkhead door was closed and all work stopped. A gage placed on a drainpipe after the bulkhead was closed registered a hydrostatic pressure of 250 lb. per sq.in.

Fig. 3—End of second stage of work. Heading after drift had been enlarged to springing line. Needle beams are supporting roof steel and sheeting.

Fig. 4—Steel frame used to support hammer and sheetpiles for full-section enlargement. Hammer carriage rode around outside of frame ribs.

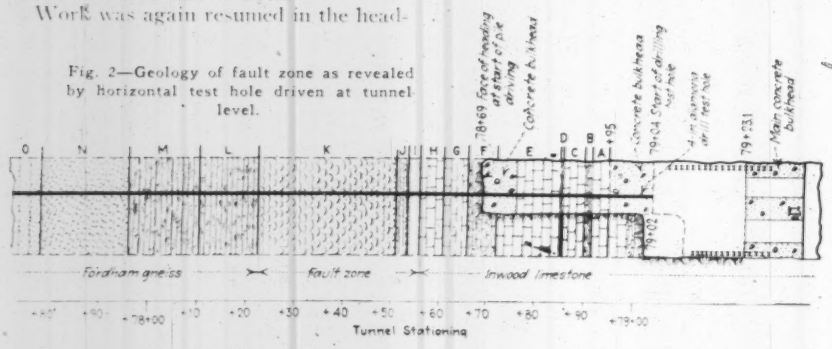


Fig. 2—Geology of fault zone as revealed by horizontal test hole driven at tunnel level.

A—Fairly pure white marble, medium grained, hard but blocky. *B*—Thin banded brown and white limestone, rich in brown and green mica, decayed and friable. *C*—Same as *A*. *D*—Same as *B*. *E*—Same as *A* except very blocky. *F*—Friable brown limestone, moth-eaten appearance. *G*—Alternating bands of brown and white limestone. *H*—Coarse-grained pure white marble with few brown bands. *I*—Greenish-black sand, chiefly chloritized mica from completely decayed and disintegrated micaceous limestone or gneiss; 250 g.p.m. flow of water. *J*—Yellowish-brown clay with hard brown lumps; completely decayed micaceous limestone. *K*—Gray clay with sharp gravel; completely decayed and disintegrated pegmatite with remnants of quartz, feldspar and biotite. *L*—Fine-grained gneiss with thin gray and black bands, friable, slightly decayed rock. *M*—Same as *L* with few harder layers; water flow 30 g.p.m. *N*—Fine-grained gneiss, hard and massive with very little decay but must jointed and blocky; water flow 20 g.p.m. *O*—Gneiss, somewhat schistose, jointed and slightly decayed; water flow 25 g.p.m. Test hole was carried on to Sta. 77 12, running into hard fine-grained gneiss, banded and jointed.

The presence of the heavy bulkhead not only saved the main tunnel (holed through to the south for some 8 miles) from being flooded but undoubtedly prevented serious disturbance of the ground at surface level. At the point where the tunnel passes under the river are tracks of the New York Central and New Haven railroads, and a new multiple-arch concrete highway bridge, crossing the tracks and river and resting on spread footings placed in the disintegrated pegmatite. Any considerable loss of ground into the tunnel might have seriously affected these structures. As it was, the inrush of mud left a good-sized cavity above the pilot drift.

New procedure required

With the closing of the bulkhead doors and shutting off of the drain pipes, it was realized that some other method of attack would be required. Before the top door had been closed it was noticed that the lower half of the chamber was filled with silt. The

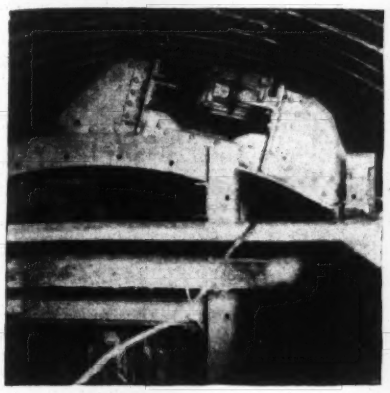


Fig. 5—Hammer in carriage driving piles for roof of drift.

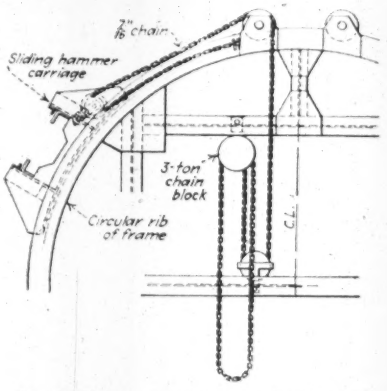


Fig. 6—Hammer carriage was handled on driving frame by hand-chain blocks.

first step in the new attack was to fill the rest of the chamber behind the bulkhead with sand and gravel. Four additional pumps were placed at shaft No. 3. Then the upper door was opened to empty the top part of the chamber, and a grout pipe was hurriedly thrust far into the heading. Another pipe for blowing in sand and gravel was placed within the chamber. The door was again closed and the chamber, filled by blowing in material was a pneumatic concrete placer. An attempt was made to fill the forward part of the chamber with gravel and the rear part with sand, this being done to relieve the pressure on the bulkhead during the grouting procedure that was to follow.

More grouting

Once the chamber was filled, a second extensive grouting schedule was started. First the chamber and cavity over the drift were grouted full. Drilling from behind and through the bulkhead, a series of diamond drill holes was fanned out in all directions, keeping above the spring line of the tunnel. Thousands of barrels of grout were pumped into these holes. Three of the holes, drilled upward at a sharp angle near the centerline of the tunnel, tapped considerable water. These holes were left open as drains and are still running water today.

After the grouting above the springing line had been completed, the lower bulkhead door was burned out and excavation of the chamber commenced from the bottom. It was found that, despite the high pressures used in grouting (as high as 700 lb.), no grout was forced into the fine silt filling the lower half of the chamber. When all of the silt and grouted sand and gravel had been removed, drilling and grouting was continued as before, the men working below the springing line. This time the diamond-drill holes were drilled into the face of the bench inside the chamber, fanning out into the sides and bottom of the tunnel.

Shield of steel sheeting

Upon the completion of this last grouting it was felt safe to begin the heading advance. The procedure adopted was to drive a top drift through to the solid gneiss, enlarge the drift to top heading down to the springing line and then take out the bench. It was in this work that the steel sheetpiling was used.

As the main bulkhead had been placed 40 ft. behind the bench face, there was ample room within the chamber for the manipulation of the hammer and piles. Because the timbering of steel ribs and plates had been previously carried forward to the bench face and then on into the heading, it was necessary to drive the sheeting inside of this steel lining.

The first step in advancing the top drift was to set up a driving frame in the top heading just inside the bench face on which the hammer and sheeting could be handled. This frame, shown in Fig. 8, was anchored to the floor of the heading. The procedure was to follow the circular roof contour with the sheeting, placing T-sheets in the roof where the sides of drift intersected the roof. Arch-web sheetpiles 30 ft. long were set upon the frame and driven ahead by a double-acting steam hammer operated by air. Steel sheeting was used for the sides of the drift as well as the roof, but the bottom was planked with boards as excavation progressed. Excavation of the drift was carried forward a few feet at a time, the sheeting being driven ahead only as excavation was removed. Timber ribs were installed to support the sheeting as excavation was removed. The face of the drift was breasted to prevent any inrush of material. After the original 30-ft. piles had been driven full length, they were spliced with 20-ft. lengths.

Once the drift was completed through the fault into solid gneiss, the next step was to enlarge it to full tunnel section down to the springing line. Two 24-in. H-beams were placed longitudinally on the floor of the drift to act as needle beams for the support of the enlarged section. A steel driving frame (Fig. 4) was set up in the chamber back of the bench face, the frame being designed for driving the full circle of sheeting.

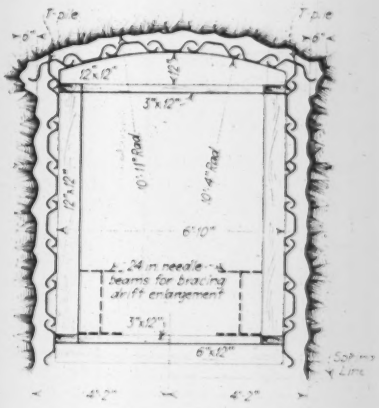


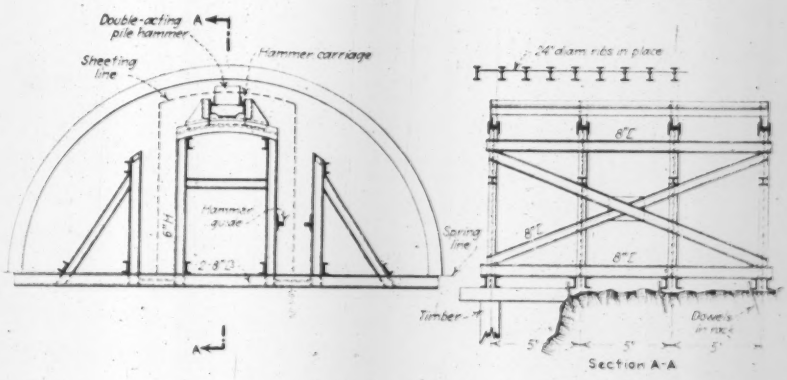
Fig. 7—Arrangement of sheetpiles and bracing for drift, first stage of driving through fault.

On the outside of the frame ribs rode a carriage handling the hammer and pile. The carriage was manipulated by hand-chain blocks (Fig. 6).

Special lining

Because of the character of ground and the high head of water to be carried by the tunnel, a special lining is now being placed through this section that will serve to carry the tunnel across the fault, acting as a beam over the soft ground. The design of this lining is shown in Fig. 9. Although this section of the tunnel had been enlarged to a diameter of 24 ft. upon approaching

Fig. 8—Steel frame and hammer carriage for driving drift sheeting.



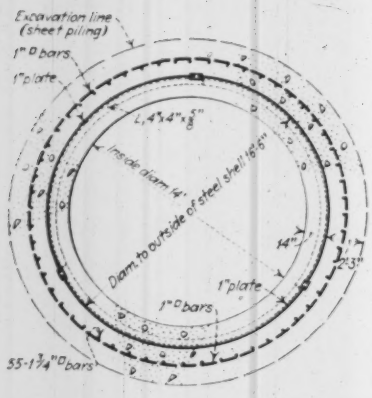


Fig. 4—Special lining of reinforced concrete and 1-in. boiler plate will carry tunnel through the stretch of soft ground.

the fault zone to allow for an increased thickness of lining, the necessity of driven the sheeting within the already-erected steel timbering before placing the extra-thick lining reduced the ultimate inside diameter to 14 ft.

First, the space between the sheeting and existing outer steel lining was filled with grout. Then a 27-in. thickness of concrete was placed next to the sheeting. This lining is heavily reinforced with 55 longitudinal 1¾-in. square twisted bars spaced 12 in. c. to c. and with 1-in. square twisted hoop bars placed every 7 ft. Inside of this concrete lining will be placed a steel pipe 16½ ft. in diameter, built up of 1-in. boiler plate, butt-jointed, in sections 46½ in. long. The sections will be flange-connected by 4x4x⅝-in. angles placed inside the shell. The steel pipe will be fabricated erect in the chamber where the main bulkhead now stands. Several sections will be built up and then skidded to place over rails laid in the concrete invert. In placing the outer lining of concrete a 6-in. clearance was left to permit placing of the steel pipe. The space between the steel shell and concrete will be grouted full under high pressure. Inside the steel pipe will be placed a 14-in. concrete lining, unreinforced.

Personnel

The tunnel is being driven for the board of water supply, City of New York, under the direction of Thaddeus Merriman, chief engineer of the board; Charles M. Clark, department engineer, and Roger A. Armstrong, senior division engineer, are in charge of construction. The Bronx section is under the direct charge of Wm. B. Hunter, division engineer. Patrick McGovern, Inc., is contractor for the entire 20 miles of tunnel. John S. Macdonald, vice-president and chief engineer, is directing the work, with Charles Harrington in charge of the Bronx section, in which the work described herein was performed. Sprague & Henwood, Scranton, Pa., were subcontractors on the diamond drilling.

Long One-Way Slabs Used in Building Design

By Charles T. Hamilton
Structural Engineer, Vancouver, B. C.

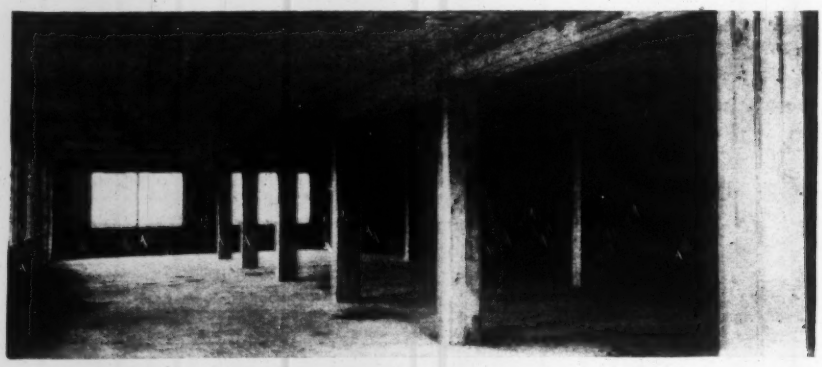
LONG-SPAN, one-way, reinforced-concrete floor slabs were used in two small buildings recently constructed in British Columbia. The apparent advantages of design were confirmed by bid figures, which indicated that the construction advantages were in keeping with the design possibilities.

The St. Louis College, Victoria, B. C., presents the usual layout required for schools with wide classrooms adjoining outer walls and separated by a comparatively narrow corridor in the center of the building. The classrooms have a clear span of 24 ft. 4 in. and offer several possibilities in design layout. In the preliminary design a comparison was made between the tile-and-joist form of floor construction and a solid slab reinforced one way. The result indicated that the solid slab would be cheaper under present price conditions, and this type was adopted. Bids indicated that a saving of several hundred dollars was made in the adoption of this type of design.

The design presents extreme simplicity of framing, as indicated in Fig. 2, and effects savings in the cost of forms, placing of reinforcement and concrete, disposition of electrical conduits and in plastering directly upon the flat undersurface of the slabs. These considerations more than offset the cost of additional concrete and reinforcing required. The slabs are 10½ in. thick with reinforcing of ⅞-in. round bars at 6½-in. centers. Temperature reinforcing is ⅜-in. round bars at 15-in. centers.

In a warehouse for Barber-Ellis, Ltd., Vancouver, B. C., the design involves a floor plan 50x120 ft., and the same type of floor was adopted. Fig. 1 shows the simplicity of design and framing as a result of this design. The reinforced-concrete frame, floors and walls cost 8.6c. per cubic foot, and the completed building 15.5c. per cubic foot.

Fig. 1—One-way slabs for warehouse floors provide simple framing and unobstructed ceiling.



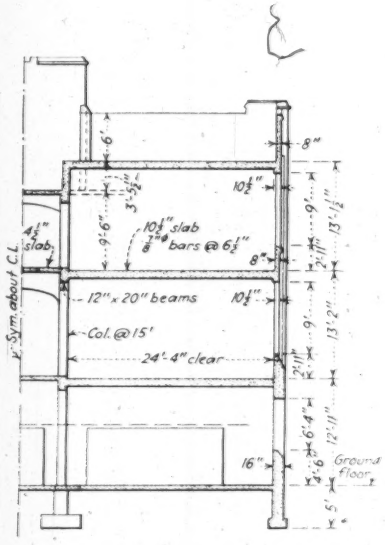


Fig. 2—Half section of St. Louis College, where one-way reinforced-slab design was used for floor framing on 24-ft. spans.

In both buildings specifications call for concrete mixes of definite strength with material tested by recognized laboratories, and results obtained were most satisfactory.

Townley & Matheson, Vancouver, B. C., were architects for both buildings, and the engineering plans were prepared by the writer. The college building was built by Luney Bros., Ltd., Victoria, B. C., and the warehouse was constructed by the George Snider Construction Co., Ltd., Vancouver.

Facts About Our Increasing Municipal Costs

Growth of population, decreased dollar value and improved standard of living have caused expansion of city services and increase in cost

THE FOLLOWING ARTICLE is the second in the series devoted to the scope and cost of municipal services. The numerical data on which the discussion is based are those published by the census bureau. It is regrettable that figures for the past two years are not yet available. But the data compiled by *Engineering News-Record* of the amount of municipal construction work undertaken each year show that the decline from the 1927 peak has continued through 1930 and 1931. It is likely, therefore, that when the government figures for these years are published it will be found that the flattening out of the total-cost curve that began in 1927 has been followed in later years by an absolute decline.

—EDITOR.

By Frank W. Herring
Engineering News-Record, Chicago

AMERICAN CITIES are not what they used to be. They are larger, fancier and costlier—unavoidably costlier. Today total city expenditures are six times as great as they were 30 years ago, a fact held by many to prove that taxpayers' money is being wasted in extravagance. But times have changed. Cities have increased in population, the purchasing value of the dollar is not what it used to be, and, most important of all, there has been a dramatic development in the social and economic life that has called forth more and more demands for the services rendered by municipalities.

There are 250 cities in the United States having a population of more than 30,000. During 1929, the latest year of record, $3,435,290,000 was spent by those cities to supply the services demanded by 43,442,800 people. In addition to "government," 3½ millions were paid for police, fire and public health protection, collection and disposal of sewage and garbage, maintaining and lighting the streets, education, charities and hospitals, parks and playgrounds, water supply and, in some cities, electric and gas service and even street railway transportation. It also paid the interest on borrowed money and for such permanent improvements as school, library and other buildings, parks, paving and the extension of various utilities. Some of the money was collected as taxes, some as license fees, some as special assessments and some as water and light bills and street-car fares.

If there were such a man as an average city dweller, having an average-sized family of 4.3 persons, and all the payments he was asked to make to the various city departments were lumped together and an itemized bill sent to him monthly, so that he could compare it with his other bills, the items would be as follows:

General government	$1.31
Protection to person and property by police and fire departments	3.04
Conservation of health and sanitation, including collection and disposal of sewage and garbage	1.56
Highways, bridges and street lighting	1.36
Charities, hospitals and correctional institutions	1.00
Education	6.00
Recreation, including parks and playgrounds	0.56
Miscellaneous, including pensions for policemen, firemen, school teachers and other municipal employees	0.81
Public services, including water supply, and other utilities operated by the city	1.35
Interest on debt	2.96
Total for maintenance, operation and interest	$19.95

At the bottom of his bill there would be a note saying: "There has also been added to your account $7.81 representing the cost of permanent municipal improvements, which you may pay immediately or in installments as you choose." If he had preferred not going into debt any farther, he would have mailed his check for $27.76 to pay for all the expenditures made in his behalf during that month. Instead of that, he preferred to make use of installment payments and remitted only $24.86, thereby increasing his indebtedness $2.90.

The sum spend by these 250 cities for permanent improvements in 1929 was $967,065,000, or 28.2 per cent of the total expenditure. It included the cost of land, engineering construction, purchase of properties and all equipment of a permanent nature. It was decidedly less than the total for 1928, when $1,036,635,000 was spent for these purposes. The total was divided as shown in Table I. It is seen that public-works items, sanitation, highways and public services do not represent the major elements of operating cost but together make up two-thirds of the total for capital outlay.

Great increase in total cost

In 1903 there were only 146 cities in the size group under consideration. The total expenditures for that year amounted to $514,189,000. Each year this sum increased, until in 1929 those same 146 cities expended $2,987,473,000, an increase of 482 per cent. On Fig. 1 the yearly figures are plotted, with the total divided into its component parts of maintenance and operation, interest, and outlay for permanent improvement.

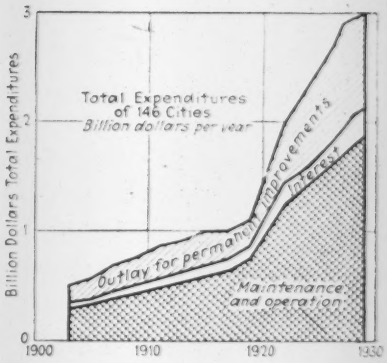


Fig. 1—The total yearly expenditure for municipal purposes in the 146 largest cities began to rise rapidly in 1919, increasing 169 per cent in the next ten years.

The most noteworthy feature of the diagram is the sharp change in the rate of increase that took place about 1919.

In 1903 the American city presented an entirely different picture from that today. Traffic was horse-drawn, and its greatest concentration was in the wholesale districts or along the water-front or at railway stations. Residential streets were largely unpaved, as we now know paving. Although Baltimore and New Orleans were not sewered completely until ten or fifteen years later, most cities were at least partly provided with public sewer systems, but only in rare instances was there anything in the nature of sewage treatment. Some few places were operating septic tanks for that purpose, and the trickling filter had just been recommended for Atlanta. Just the year before the first rapid-filter plant of the type we see today had been put into operation at Little Falls, N. J., but many of the other water-purification plants that existed were of the expensive slow-sand type. Milk was sold in bulk from milk wagons. On Sunday afternoons recreation for the most part consisted of walking or riding in the street car to the public park, if one worth visiting existed, to enjoy the beauties of the grass, flowers and trees. Practically all the education provided by the city consisted of elementary grades, housed in dingy red-brick buildings with narrow corridors and inadequate ventilation, with the front street as a very poor substitute for the playgrounds now so common. Police patrolmen made their rounds afoot, and night life was confined largely to a few metropolitan centers.

TABLE I—OUTLAY FOR PERMANENT IMPROVEMENTS IN 250 CITIES, 1928

General government	$24,882,000
Police and fire	27,879,000
Conservation of health	3,312,000
Sanitation	157,329,000
Highways	389,688,000
Charities, hospitals and corrections	21,765,000
Education	178,676,000
Recreation	73,018,000
Miscellaneous	3,951,000
Water-supply systems	95,831,000
Other public service enterprises	60,764,000
Total	$1,036,635,000

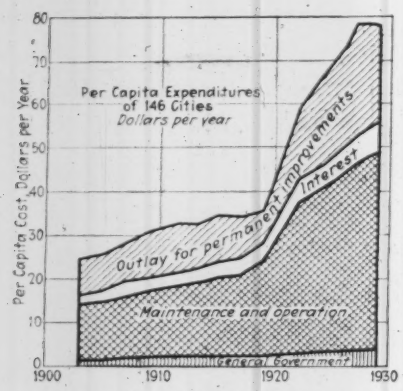


Fig. 2—When the total expenditures are computed on a per-capita basis the increase in cost between 1919 and 1929 reduces to 119 per cent.

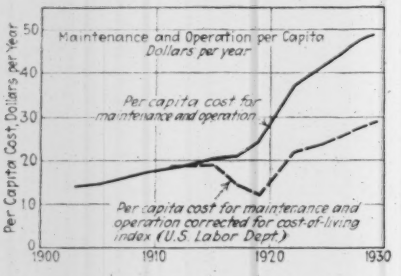

Maintenance and Operation per Capita
Dollars per year
Per Capita Cost, Dollars per Year
Per capita cost for maintenance and operation
Per capita cost for maintenance and operation corrected for cost-of-living index (U.S. Labor Dept.)
1900
1910
1920
1930

Fig. 3—There has been only a 50 per cent increase in the per-capita cost of maintenance and operation since 1913 when the changing value of the dollar is considered.

As population increased, the cost of maintaining city government and providing municipal services increased likewise. This was to be expected, as the trend was toward urbanization and the population of the cities increased more rapidly than that of the country at large. On reducing the total expenditures to a per-capita basis we find that although the total expenditure of the cities under consideration increased 482 per cent between 1903 and 1929, the per-capita cost increased only 216 per cent in the 26 years. In Fig. 2 is shown the per-capita cost for the intervening years. The change in the rate of increase at the year 1919 is also evident here. But, unlike that for gross expenditure, the per-capita-cost curve shows a decrease for the last two years of the period, due entirely to a decrease in the outlay for permanent improvements.

But another factor, more important than changing populations, should be taken into consideration in making year-to-year comparisons of municipal expenditures. The value of the dollar has not remained constant. Based on the increase in the cost-of-living index, a 1913 dollar was worth only 58.4c. in 1929. It follows, therefore, that instead of the per-capita cost of maintenance and operation rising from $19.02 to $48.88, or 157 per cent, in the sixteen years from 1913 to 1929, the rise was only $28.50, or 50 per cent, in 1913 dollars. Further, if only general governmental functions are considered, including legislation and general administration, election of personnel, collection and disbursement of funds and the administration of justice, the increase in 1913 dollars was only 6.5 per cent, from $2 to $2.13 per capita. In Fig. 3 this correction has been applied to the maintenance and operation cost of the 146 cities. The most notable feature of this curve is the sharp decrease in real cost between 1915 and 1919 when prices rose so fast. It is evident that during this period the salaries of municipal employees did not rise with the increase in cost of living.

Changed dollar value

The correction for dollar value gives even more striking results when applied to the expenditures for permanent improvements. In Fig. 4 the per-capita expenditure figures for this purpose have been plotted both in actual dollars and in 1913 dollars, the correction being based on the *Engineering News-Record* construction-cost index. In this case it is seen that, even before correction, the per-capita expenditure curve shows two periods of marked decrease, from 1915 to 1919, while the whole world was at war, and from 1927 to 1929. But when the correction for dollar value is made, the curve takes an entirely different form. One peak was reached in 1911, after which expenditures proceeded at a fairly uniform rate until the war years arrived, during which the productive energies of the country were devoted to other matters. Following the war, permanent improvements began to be added at an increasing rate to make up for the period of neglect until another peak was reached in 1927. But even so, the 1927 improvements exceeded those of the 1911 peak by only 6 per cent.

Large cities cost more

In addition to these readily evaluated factors causing increases in cost, there are some whose effects are not easy to measure. One such factor is what might be called a second-degree population effect. Increasing population makes for increasing per-capita costs. That this so is not to be denied, although the reasons for it are not immediately obvious. In Table II are shown the per-capita costs for maintenance and operation of five different-sized groups of cities. It can be seen that the per-capita cost increases fairly regula as the size of the city increases.

In the first place, additional serv must be provided by the city a increases in population. For exam in a very small community water quently comes from private wells a sewage and garbage are disposed of the premises. A single road thro the center of town is all that requi paving and that may be paid for some other governmetal body. protection can be provided adequat by a volunteer department and a c stable or two have no difficulty in mai taining order. As the city's size creases, water supply becomes of nec sity a community problem. Slowly creasing congestion makes the pub health problem more serious, and c lection and disposal of sewage a garbage become necessary on a co munity basis. Traffic increases fas than does population, many residenti streets become thoroughfares requiri high-cost paving, and better street su faces are required everywhere else.

As the city approaches the metropol class, not only does it become necessa to add further functions to its gover ment, but those already in existen must be expanded. The fire departmen

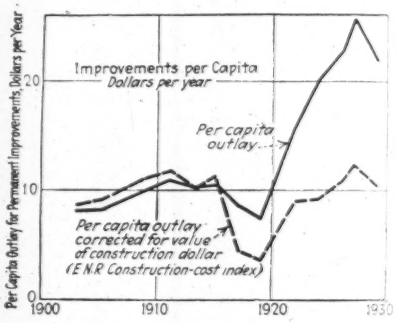


Fig. 4—Per-capita expenditure for permanent improvements, stated in terms of 1913 dollars, fell to a low point during the war years. In 1927 it reached a value only slightly higher than that of 1911, the previous peak. Figures for 1930 and 1931 are not yet available.

has its work made more difficult by tall buildings and wide areas of operation. Not only must the police department cover a larger territory, but its field of activity becomes expanded and complicated by the social problems that invariably accompany a big city. Every residential street becomes a thoroughfare to feed traffic to the wide-paved boulevards. Traffic regulation by policemen, lights and street marking must be provided. Parks and playgrounds become desirable to relieve the shortage of recreation space. Public health requires increasing attention. Water purification at greater cost must be provided, even when the water is brought at great expense from a distance. The volume of sewage produced becomes so great that a treatment plant is neces-

TABLE II—PER-CAPITA COST FOR MAINTENANCE AND OPERATION AND INTEREST FOR CITIES OF DIFFERENT POPULATION CLASS

Population,	1929	1928	1917
500,000 and over, 13 cities	66.21	64.40	29.96
300,000 to 500,000, 11 cities	61.26	59.87	27.77
100,000 to 300,000, 65 cities	44.52	43.65	19.75
50,000 to 100,000, 92 cities	42.71	41.58	17.78
30,000 to 50,000, 69 cities	41.01	40.22	17.76
Average, all cities over 30,000 population	55.69	54.31	24.70

sary if the neighboring waters are not to become grossly polluted. Sewer and water lines must be extended great distances, requiring either intermediate pumping stations or disproportionately high unit costs of service. More ambitious demands are made upon the educational system, and city colleges, public libraries, art museums and zoos are created.

Add to the foregoing factors the higher living costs in a large city, requiring more adequate compensation of personnel, and the growth of per-capita cost with increased city size does not appear mysterious. Each city in its years of growth experiences increasing costs somewhat greater in magnitude than would be expected from the increase in population alone.

New services demanded

But far more important than any of the factors discussed so far are the effects of the social and economic developments we have experienced in the past 25 years. The unparalleled production of wealth resulting from the industrial exploitation of scientific discoveries has played a tremendous role in encouraging demands for new services and the expansion of old ones. And increased wealth, increased scientific knowledge and changing social concepts have led to community efforts to improve in some degree the condition of the less prosperous citizens.

Modern cities have assumed new obligations since the day when Thomas Jefferson said, "That government is best which governs least." We have left that dictum far behind in developing a technological era. Unless we are to confine its meaning to the purely governmental aspects of municipal administration and consider separately the service functions now such a vital part of community life, the application of the Virginia stateman's principle would make the city of 1932 an intolerable place in which to live.

The contrast between the city of today and its counterpart in the past is well illustrated by a passage from the 1868 annual report of the Toledo health officer. That report calls attention to the outstanding health problem of that day in these words: "Swine, whether in pens or at large, are confessed, by all persons not engaged in cultivating them, to be decided nuisance when permitted to exist in a city. A laudable desire to promote the public amiability and add to the comfort of the non-hog-growing portion of our citizens led to the strict enforcement of an ordinance restricting the liberty of the scavenger quadruped, whose faithful services in consuming the garbage thrown into the street was thought to be no compensation for the annoyances they occasioned to tidy housewives and owners of grass plots."

Today cities not only forbid the throwing of garbage into the street and refuse to furnish free range for swine, but they facilitate industry and commerce, aid the sick and the poor, protect the well, insure their own employees, safeguard life and property and provide uncounted conveniences for householders. Scientific discovery and the increased wealth it has made possible have brought about a higher standard of living, creating increasing demands for new public services. Water is purified, parkways are built and planted, educational facilities are expanded, ashes and rubbish are carted away, sewers are extended, street lighting is amplified and monumental public buildings are constructed. Modern industry encourages congestion of population and in turn necessitates expensive parks and playgrounds, costly fire and police protection and facilities capable of transporting thousands of people long distances at high speed.

Even the early, elementary functions of government have multiplied in variety and cost compared with the earlier years, but these additions to municipal expenditures are small compared with those of the new service functions that have arisen and expanded with the growing complexity of urban civilization. And it merely confuses the issue

TABLE III—YEARLY MAINTENANCE AND OPERATION COSTS OF 146 CITIES

	1913	1929	Per Cent Increase
Total (millions)	$535	$1,873	250
Per-capita, actual	19.02	48.88	157
Per-capita in 1913 dollars	19.02	28.50	50
Per-capita cost of general governmental functions in 1913 dollars	2.00	2.13	6.5

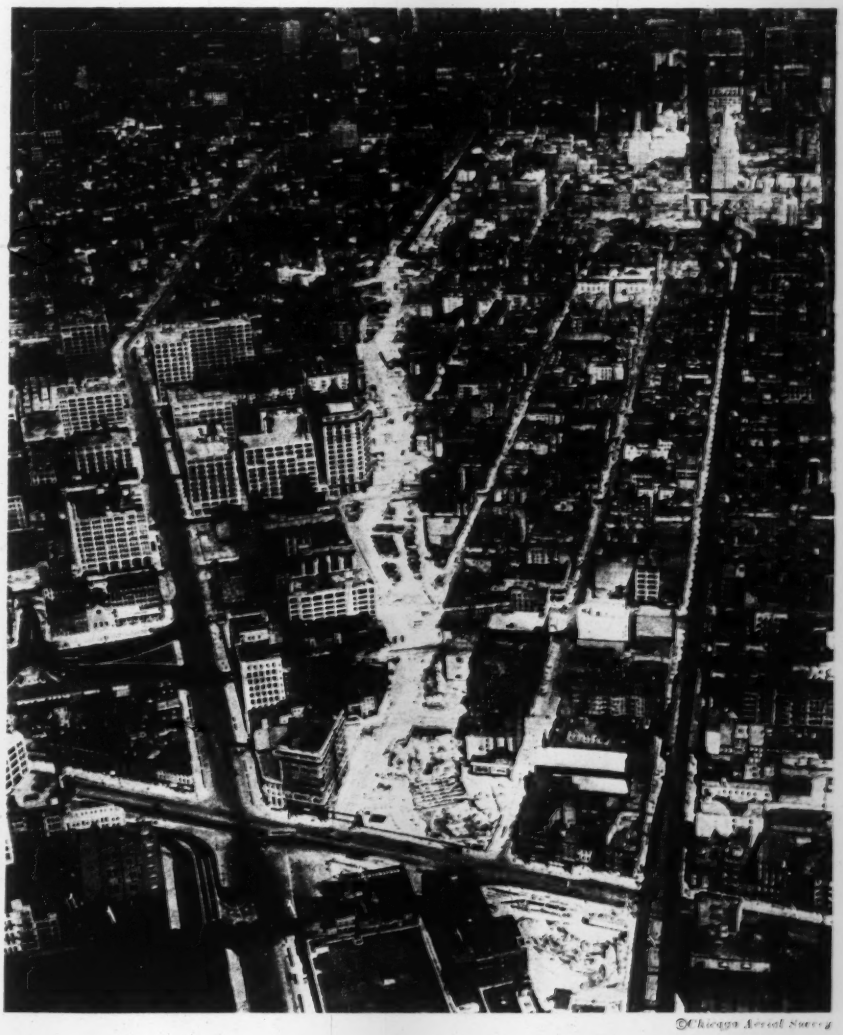


Fig. 5—The many channels for municipal expenditures that develop in our growing cities are emphasized by this picture of New York taken at the time the extension of Sixth Ave. south to Canal St. was in progress. Opening of the Holland vehicle tunnel (lower left) brought with it a demand for more and wider streets and better pavements, for better lighting and traffic control. It brought also the development of a new warehousing and manufacturing zone with large buildings needing more water and adequate high-pressure fire-fighting facilities. To supplement the subway (under Varick St. at the left) and the elevated line (at the right), both overtaxed, the city is building a subway under Sixth Ave. extension.

©Chicago Aerial Survey

to call the resulting increase in cost an increase in the cost of government. A street-widening program adds to the cost of facilitating public transportation but certainly not to the cost of government. The same is true with a new bridge, a new high school or a new sewage plant. Even a city devoid of government, an anarchic city, would in some way provide these municipal services or perish, and if provided they would still cost money.

New social responsibilities have been recognized in connection with developments in medical science. With the means now available for protecting public health, governmental organizations on every level have expanded their health departments so as to utilize these developments to the best advantage. Milk and food inspection, purification of water, smallpox vaccination, diphtheria and typhoid immunization, collection of mortality and morbidity records, segregation of cases of contagious disease and many other measures designed to protect the public health have wisely been assigned to the community at large for administration. Has that expansion been unwise? The gratifying record made in the past few decades not only in the control of communicable disease but also in the reduction of the general death rate leads to the conclusion that these measures should be continued with undiminished vigor.

Growth in education

Just as our knowledge of public health has advanced and has been applied to the benefit of society at large, there has been a tremendous growth in the demands made upon our educational systems to make our rapidly expanding body of knowledge available to more and more people. Where at one time the public school system's efforts were confined to a few months' instruction in the three R's, they now involve regular elementary and secondary schooling, summer schools, technical schools, schools for the incorrigible, the mentally backward, the blind and crippled. Perhaps some of the development in athletic facilities have been unwise, but they have run parallel with the remarkable growth of organized recreation all over the country and have been undertaken largely with the approval and often at the demand of enterprising citizens and taxpayers.

However much our expansion of educational facilities may fail to balance with our ability or willingness to pay, it has not been undertaken merely to create more teaching jobs or lucrative building contracts. Pupils perched on windowsills because of the lack of seating space is only one aspect of the general condition of overcrowding with which we are all familiar. Increased leisure, increased wealth and increased appreciation of the value of schooling have led to public demands that could not be ignored. In the ten-year period between 1920 and 1930 the high-school attendance in the country increased from 26 to nearly 50 per cent of the population between the ages of fourteen and seventeen.

Effects of the automobile

But undoubtedly the most important factor of all in the increase in city cost has been the development of the automobile. There is no aspect of municipal activity that it has not vitally affected. Police departments are faced with entirely new problems in the apprehension of criminals. Fire departments have had their technique completely changed. With greatly increased accessibility, parks become exalted playgrounds rather than conservatories. The public streets no longer remain available as playgrounds for school children, and recreational facilities in the educational system become expanded. And, of course, the necessity for prodigious expansion of boulevard development, street paving, bridges and street lighting is obvious.

One direct effect of the automobile has been the rapid growth of residential communities in the cities' outskirts. Real estate subdividers certainly did nothing to hinder such development. Vacant lots, not destined to be utilized for 50 years in many cases, are serviced by water and sewer lines and paved streets. The owners are specially assessed for the costs of such service, it is true, but whether the assessments are paid or not the total costs are included in the figures given as the "cost of government."

Much of our confusion in thinking about governments, their cost and the services they render is due to our proneness to consider those services which have been added most recently as of questionable desirability and to assume that all the older ones are inherently governmental in nature. But a study of the dates at which particular services were started shows that the broadening of knowledge and the development of social and economic conditions has been reflected faithfully in the mirror of governmental functions.

When the Detroit government was established, in 1824, its functions numbered 23. They consisted largely of legislation and administrations; assessment of miscellaneous revenue; collection, custody and disbursement of funds; enforcement of local ordinances; maintenance of a few public buildings, some unpaved streets and the public markets; control of weights and measures, and a modicum of fire prevention.

Services added recently

A publicly supported elementary day school was not set up until 1842, a public high school not until 1858. The police and fire departments were created in 1865 and 1867 respectively. A public night school was first established in 1875. Garbage collection and disposal was made a community enterprise 1888. Street cleaning was begun 1895. Since the turn of the century many functions have been added which reflect our social and economic history mostly within the period covered by the cost summaries given earlier in the discussion: 1904, playgrounds; 1906, evening high schools; 1906, comfort stations, branch libraries; 1908, public health, nursing; 1909, traffic control; 1912, technical high schools; 1917, junior college; 1921, psychiatric examination of offenders; 1922, public golf courses; 1923, water filtration; 1925, mosquito control; 1927, scientific police laboratory, 1929, airport; 1930, municipal lodging house.

Better administration

The ability of men to live together amicably, safely and conveniently is one measure of civilization. The expansion of municipal services has been an effort to improve that ability. The claim that we have carried our efforts too far is an admission that our total income has not yet reached the point where we can afford to ride on paved streets, to be protected from epidemics and to educate our citizenry to the degree we desire. There is little doubt, however, that improvements can be made in the efficiency and economy of city administration. How efficient and economical a city administration is or can be will be discussed at length in the next article of this series, to be written by C. A. Dykstra, city manager of Cincinnati.

Municipal governments have not extended their functions by pressure from within the city hall, but by forces applied from without. The expansion has been considered desirable or essential as we have developed. Today, with slender purses, we find the payment hard to make. But at the same time the desirability of those functions is greater than ever before. The collapse of business has accentuated rather than decreased the value of the services that make urban civilization possible.

Czechoslovakian Road Construction

Some 375 miles of important intercity roads were built in Czechoslovakia during 1930 and 1931. At present the construction of through highways is beginning, including a road through Pilsen and Prague to Breslau and Warsaw, and a road through Prague connecting Berlin and Vienna. One of the innovations used in recent road construction was made on the state road between Nitra and Levia, where a paving material called "Siberyt" as used. This is said to be a mixture of cement and glass powder which is cheaper than bituminous surfacing and is claimed to have greater strength, resistance to traction and temperature than concrete.

New Research Foreshadows Changes in Concrete Art

American Concrete Institute convention in Washington receives important reports on masonry walls, concrete columns, concrete arches and truck-mixed concrete—Eight honorary members elected

THE 28th annual convention of the American Concrete Institute, held in Washington, D. C., March 1-4, was predominantly a research meeting, although descriptions of such important work as the construction of the Mount Vernon highway, the building of concrete-arch bridges in Allegheny County and the Chats Falls hydro-electric development in Canada gave variety to the program. Among the important researches reported were the reinforced-concrete column investigation carried out jointly at Lehigh University and the University of Illinois, masonry-wall studies of the University of Illinois and Portland Cement Association laboratories, and an investigation of truck-mixed concrete. The concrete-arch committee also presented a report that proposes several new concepts of arch design and analysis, principally centering on the phenomenon of plastic flow.

Attendance at the convention was not as large as formerly, but interest in the proceedings was particularly notable. Part of the important business of the meeting was the awarding of medals and of certificates of honorary membership. Previous to this meeting the institute had only one living honorary member, Adolf Bühler, chief bridge engineer of the National Swiss Railways. The eight new honorary members are Edward D. Boyer, William K. Hatt, Robert W. Lesley, Arthur N. Talbot, Sanford E. Thompson, Frederick E. Turneaure, Henry C. Turner and Leonard C. Wason. Duff A. Abrams was awarded the Henry C. Turner medal, and Raymond E. Davis and Harmer E. Davis, University of California, were awarded the Wason medal.

S. C. Hollister, Purdue University, was elected president for the coming year. Arthur R. Lord was reelected vice-president. John J. Early, prominent exponent of and expert in colored concrete, was added to the board of directors.

Masonry walls

Concrete masonry, in so far as its structural performance is concerned, was given more concentrated consideration than for a number of years past, in a series of research reports on strength of wall panels and wallette specimens at the University of Illinois, and on wallettes at the P.C.A. laboratory, with and without exposure to fire. An investigation of masonry cements by the research department of the Lehigh Portland Cement Co., as well as considerable pertinent discussion, also formed a part of this session.

F. E. Richart presented the results and conclusions of the investigation at the University of Illinois involving 70 wall panels 6 ft. long by 9½ ft. high and 44 wallette specimens 32 in. long and 4 ft. high. The results are given in the accompanying table. All walls were built when the blocks were 28 days old, and tests were made after an air-curing period in the laboratory of 32 days. Two conclusions, which are unusually important since large wall panels have not been extensively tested previously and data therefore have been lacking, are: (1) The compressive strength of a wall panel depends upon the strength of the individual units, and in this investigation was 53 per cent of the strength of the unit; and (2) the ratio between compressive strengths of large walls and wallettes is fairly constant, with an average value of 0.91. The first conclusion is directly applicable to wall design practice, the second to investigational work on walls. Based upon working stresses of 70 and 80 lb. per sq.in., the factor of safety of the walls in compression varied from 4.4 to 11.5. Failure usually started at the joints, with crumbling of mortar and splitting off of adjacent edges of the units, and the high concentration of stress at joints was also shown by relatively large (2 to 4 times) deformations in a 2-in.-gage length across the joints as compared with those in 6-in.-gage lengths within a single unit. Face-shell bedding of joints produced a wall with only 80 per cent of the compressive strength of a full-bedded wall. Composite walls developed high strengths and showed satisfactory interaction of the materials; although deformation of the concrete face in some cases markedly exceeded that of the brick face; ratio of wall strength to unit strength was much greater than for plain walls. Walls under eccentric loads applied at the edge of the middle third of the thickness were about ¾ as strong as axially loaded walls; this large effect of a small eccentricity (1¼ to 2 in.) is notable. From the lateral-strength tests in which the walls were loaded at mid-height as a vertical beam restrained at top and bottom, it was found that flexural strength depended upon adhesion of mortar to unit, with failure following a horizontal joint. The computed modulus of elasticity for the walls tested ranged from 500,000 to 1,170,000 lb. per sq.in. of gross area.

Strength of walls after fire exposure was discussed by C. A. Menzel, Portland Cement Association, in a report of a series of tests begun in 1928 and recently completed on 210 walls, 5½x6 ft., of which 175 were subjected to the standard fire-load test and 35 were tested without exposure. In both of these series the wall strength was found to be directly proportional to strength of concrete units (checking Richart's results) and averaging 55 per cent before and 28 per cent after exposure to fire. The type of joint or amount of bedding was the principal factor affecting strength, the effect increasing in walls exposed to fire. Type of aggregate had no effect on unexposed wall strength but showed an appreciable effect after fire exposure. The design of the concrete unit (shape or arrangement of cores) did not particularly affect wall behavior in the fire test. The outstanding feature of the test was the substantial load-carrying capacity developed by all walls before, during and after severe fire exposure, regardless of many variables, such as mortar mix, type of unit and amount of bedding. High and uniform strengths were obtained both before and after fire exposure for walls with mortar containing up to 70 per cent cement. Additions of cement above this amount produced a decrease in strength of the wall. Full mortar beds gave strengths 60 per cent greater than ¾ mortar beds after fire exposure.

S. H. Ingberg (Bureau of Standards) pointed out the important effect of workmanship on wall strength. At the Bureau of Standards, in order to simulate as closely as possible actual building practice, masons are paid a commercial rate for building test specimens. Mr. Ingberg stated his experience had shown that a predominance of coarse aggregate in units stimulates spalling. He questioned the value of testing walls to failure after fire exposure (as was done by Mr. Menzel) because web cracking from the heat might seriously impair the wall strength in flexure, if not in bearing. This web cracking makes the re-use of walls after fire exposure questionable. Mr. Menzel stated that he believed there was little web cracking in the walls he tested, as several walls were dismantled after fire exposure to be examined for this condition.

H. E. Gonnerman reported a related series of wallette tests made at the Portland Cement Association laboratory, in which Richart's factor of 0.91 was used to convert results to actual wall conditions. Primarily, this investigation was made to study the effect of mortar strength on wall strength. As in Richart's results for a given mortar, wall strength was directly proportional to strength of units; with strength of units

varying from 700 to 1,000 lb. per sq.in., walls using these units showed strengths from 340 to 665 lb. per sq.in. Various aggregates showed no other effect than that they governed to some extent the strength of the units.

It was concluded from the Portland Cement Association investigation that to develop full strength of the wall, the mortar strength must be as great as the wall strength. This claim was later challenged as to its importance in a discussion of a paper on properties of masonry cements given by J. C. Pearson, director of research, Lehigh Portland Cement Co., in which strength appeared far down on a list of important properties of masonry cements. Strength was generally admitted to be a min... although not unimportant quality ... mortar used in ordinary walls. W. D. ... Allen, Portland Cement Associatio... pointed out that strength is relativel... more important when using hollow unit... as is general, than when solid units wit... an opportunity for a full-bedded joi... are used. In the opinion of A. ... Malmed (Philadelphia) both those urg... ing strength and those urging plasticity as a prime requisite of a mortar ar... wrong, and perhaps a tempering of opin... ion toward some middle attitude would be more nearly in accord with the fact.

Mr. Pearson listed the important properties of a masonry cement in the fol... lowing order: plasticity, volume change, durability, bond, elasticity, rate of stiffening, efflorescence, impermeability, strength and staining or fading.

PRINCIPAL RESULTS OF MASONARY WALL TESTS
(UNIVERSITY OF ILLINOIS)

Lot and Wall No.	Type of Unit	Aggregate	Mortar Mix (3)	Compressive Strength (Lb. per Sq.In.) Large Walls	Small Walls	Units(1)	Mortar(2)	Modulus of Rupture Lb. per Sq. In.	Strength Ratios Large Walls to Small Wall	Large Walls to Unit	Ratio Moduli of Walls to Units	Factor of Safety Walls in Compression(5)
Axial Loading												
1CF		Cinder	A	445	450	865	1280	34	0.99	0.51	0.64	6.3
1CS		Cinder	A	350	380	865	1190	42	0.92	0.40	....	5.0
2HF	8-8-16"	Haydite	A	455	470	820	1010	47	0.97	0.56	0.87	6.5
2HS	3-oval-core	Haydite	A	370	390	820	940	28	0.95	0.45	....	5.3
3GF	Core area	Sand-Gr.	A	610	655	1070	820	19	0.93	0.57	0.82	8.7
3GS	37%	Sand-Gr.	A	450	495	1070	840	23	0.91	0.42	....	6.4
4LF		Limestone	A	390	460	780	1100	18	0.85	0.50	0.68	5.6
5SF	8-8-16"	Slag	A	540	590	1290	1170	27	0.92	0.42	0.78	7.7
6HF	3-oval-core	Haydite	A	440	520	1280	1550	18	0.85	0.34	0.49	6.3
7CF	Core area	Cinder	A	515	595	970	1230	18	0.87	0.53	0.65	7.3
8GF	37%	Sand-Gr.	A	695	635	1230	820	38	1.09	0.57	0.64	9.7
9CF	8-8-16'	Cinder	C	610	635	1150	1850	22	0.96	0.53	0.51	7.6
10GF	3-oval-core	Sand-Gr.	C	355	370	550	1890	23	0.96	0.65	0.52	4.4
11GF	Core area 37%	Sand-Gr.	C	780	940	1570	1930	36	0.83	0.50	0.80	9.9
12GF	5-8-12" 2-sq.-core Core area 57%	Sand-Gr.	A	585	705	1360	1250	46	0.83	0.43	0.60	8.3
13GF	3½-8-12" 2-sq.-core Core area 30%	Sand-Gr.	A	630	775	1550	1190	28	0.81	0.41	0.62	9.0
14GF	8-12-16" 3-oval-core Core area 39%	Sand-Gr.	A	370	400	600	1100	18	0.93	0.62	0.65	5.3
15HF	8-12-16" 3-oval-core Core area 39%	Haydite	A	365	370	670	1010	27	0.99	0.54	0.81	5.2
16HF (4)		Haydite	B	685	635	710* 990	985	30	1.08	0.97 0.69	.....	9.8
16HS (4)	8-8-16" 3-oval-core	Haydite	B	545	640	520* 720	1250	38	0.85	1.05 0.76	.....	7.8
17CF (4)	Core area 37%	Cinder	B	805	780	1050* 810	1110	50	1.03	0.77 0.99	.....	11.5
Eccentric Loading (Edge of middle third of wall thickness) Unit Stresses Are Average												
18HF	8-8-16"	Haydite	A	400	475	1040	950	.....	0.84	0.38	0.69	.....
19CF	3-oval-core	Cinder	A	355		850	1305	.....	.....	0.42	0.99	.....
20GF	Core area	Sand-Gr.	A	425		1010	1580	.....	.....	0.42	0.92	.....
21GS†	37%	Sand-Gr.	A	515		1480	1280	.....	.....	0.35	0.48	.....
Axial Loading, Thin-Walled Units												
A	8-8-16" 3-oval-core Core area 45%	Haydite	A	410		805	1220	40	.....	0.51	0.82	5.9
B	8-8-16" 3-sq.-core Core area 55%	Haydite	A	365		720	860	40	.....	0.51	0.74	5.2
C	8-8-16" 3-oval-core Core area 45%	Haydite	B	700		805	1190	39	.....	0.87	.....	10.0
D	8-8-16" 3-sq.-core Core area 55%	Haydite	B	650		720	1470	31	.....	0.90	.....	9.3

Mortar joints, full mortar bed except walls marked 1CS, 2HS, 3GS and 21GS, which were bedded on face shells only.
Strengths of walls and units are based on gross areas.
(1) 60-day tests.
(2) 2 by 4-in. cylinders, 32 days old.
(3) Mortar mixtures, by dry rodded volumes: (A) 1:1:4½, cement-lime mortar, (B) 1:1½:4½, cement-lime mortar, (C) 1:3 cement mortar, with 10 per cent lime.
(4) Composite walls with shale brick facing.
(5) Allowable stress 80 lb. per sq in. on lots 9, 10 and 11; 70 lb. per sq.in. on others.
Composite walls, 4-in. face brick, 8-in. concrete unit.
*Strength of offset units of alternate courses.
†Units 3 months old when wall was built. Walls tested when 32 days old.

Reinforced-concrete columns

In the reinforced-concrete column investigation that has been under way during the past two years about 600 columns have been tested, and with the exception of a few columns held out for sustained-load observations during another year or two the study is complete. The committee has drawn no final conclusions from the investigation, but the reports of the two laboratories (Lehigh University and University of Illinois) are complete, with separate conclusions that were briefly presented at the meeting. The full investigation will be reviewed later in these pages, but of the important results obtained it may be noted that the efficiency of spiral reinforcement was found to be from 1½ to 2 times that of the vertical reinforcement. Thus the strength of a column may be divided into three elements—75 to 85 per cent of the control cylinder strength of the concrete times the net core area plus the total yield-point strength of the longitudinal reinforcement plus the total yield-point strength of the spiral reinforcement times the effectiveness ratio of 1½ to 2. Another notable conclusion is that no difference was found in the ultimate strength of columns held under sustained loading for a year and companion columns not loaded. However, the stress in the steel increased appreciably in all columns under sustained working loads, values of n increasing from 4 to 6 times during a year, with the major part of this increase occurring at the end of five months. In the large columns tested (up to 28-in. core diameter), the effectiveness of the spiral was found to be similar to that found for 8-in. columns, namely 1½ to 2 times the vertical steel effectiveness. Scale effect between large and small columns was negligible, both following the same general laws.

In discussion Prof. A. N. Talbot (University of Illinois), suggested that any new methods of design made possible by this new knowledge of column

behavior should recognize the diverse types of service in which columns are used. Perhaps there should be different design formulas for each type of service, he said. Prof. W. O. Withey (University of Wisconsin) called attention to the very considerable toughening effect contributed to all columns by spiral reinforcement; columns with only vertical reinforcement fail too suddenly to be safe to consider in practice.

Concrete arches

Distinct advance in the knowledge of concrete-arch bridges was recorded in two papers and a committee report on the subject. The Freyssinet method of arch construction, in which a strain is introduced by jacking to compensate the effect of strains that later develop from shrinkage and plastic flow, was described by A. L. Gemeny, Bureau of Public Roads, in its application to the Rogue River bridge in Oregon, and was challenged as to its usefulness by Charles S. Whitney, chairman of the concrete-arch committee, in a report that was read in abstract form by Prof. Clyde T. Morris.

The second paper on "Design of Concrete Arches in Allegheny County," by G. S. Richardson, assistant engineer, Bureau of Bridges, reviewed the design of the six bridges on the Ohio River Boulevard and of the George Westinghouse Bridge in East Pittsburgh. Neither the Rogue River bridge construction nor the Allegheny County bridges will be considered in detail here, for the former is soon to be described in these pages by the designers, and the latter, in so far as the George Westinghouse Bridge is concerned, was described in an article in *Engineering News-Record* of April 23, 1931, p. 681. Mr. Richardson, however, reported several additional facts, based on a study of these several bridges with wide range in length, rib cross-section and rise-to-span ratio, that have a distinct bearing on some new concepts of arch design. Floor-expansion joints are used only at the end of the George Westinghouse Bridge spans, with a consequent reduction of 40 per cent in live-load moments. Mr. Richardson stated that field observation of the Ohio River Boulevard bridges, in which expansion joints occur at four or five panel intervals, shows that nearly all of the movement occurs at the end joints, substantiating the Westinghouse design, which was based on models. Regarding the relative safety of shallow and wide ribs and deep and narrow ribs, Mr. Richardson's study convinced him that arch-shortening stresses from shrinkage and temperature may account for more than 50 per cent of the total stress in deep ribs. Because of uncertainty in calculating such stresses, shallow ribs can be looked upon with more favor. In addition, the study showed that shallow ribs with a crown depth of 1/80 or 1/100 of the span provide for direct dead- and live-load stresses almost as well as the 1/50 ratio commonly used. The width of shallow ribs furthermore adds to lateral stability both for the centering during construction and for the rib in the completed structure.

The committee report comprises an unusually stimulating discussion of concrete-arch design fundamentals. It places definite limits upon the theory of elasticity as now used and makes a definite presentation of means to design for the effect of plastic flow, shrinkage and temperature variations. Some of the conclusions are new and some are contrary to accepted ideas. In this report, which is largely analytical but makes use of all available data, it is indicated that the modulus of elasticity of concrete is nearer 4,000,000 than 2,000,000, as commonly assumed. A similar conclusion was reached by the concrete column investigators.

In general, the theory propounded rests on the plasticity of concrete, which, while it increases rib shortening under dead load, also relieves stresses produced by flexural deformation of the rib from any cause. The theory of elasticity involves the concept of strain produced by stress; the report on a plasticity theory reverses the concept and considers also stress produced by strain. Such stresses cannot be calculated from extensometer measurements. No means of interpreting laboratory results in terms of field experience exists, so that definite information regarding the limiting values of shrinkage, plasticity and temperature will not be available until observations are made on crown movements during the five- or six-year periods during which adjustment is under way. However, on the basis of his analysis Mr. Whitney concludes that the initial stress produced in a concrete arch by a bending strain introduced at an early age, such as by Freyssinet's jacks, is largely eliminated by plastic flow. On the other hand, the Freyssinet method of construction may have value purely as a method of decentering and of cambering a flat arch to prevent excessive crown sag. Decentering by any means at an early age decreases the stresses in the concrete (partly due to abutment displacement) and increases them in the steel. Plastic flow also reduces bending stresses in the concrete about 75 per cent due to shrinkage rib-shortening, but there is no reduction in steel stress; thus the effect of shrinkage on the concrete may be equivalent to about a 12-deg. drop in temperature, but on the steel the equivalent temperature drop is nearer 50 or 60 deg. These high steel stresses are not equalized by plastic flow as are the concrete stresses although the plastic flow that does occur in the steel will prevent the total steel stress from materially exceeding the elastic limit. These high steel stresses, which were also observed in the reinforced-concrete column investigations, make efficient splices and closely spaced ties extremely important.

Truck-mixed concrete

Some of the comparative characteristics of truck-mixed and plant-mixed concrete, as well as some features of different types of truck mixers, were brought out in a series of tests reported by S. C. Hollister and in discussion initiated by Cloyd M. Chapman, consulting engineer, New York. Mr. Hollister found in 22 runs of a Jaeger truck mixer, into which materials were charged dry and then mixed with water for various periods up to 1½ hours, that, regardless of mixer speed, all mixes were adequately mixed in from 40 to 60 revolutions of the drum, and that in general no improvement or decrease in strength of the concrete was secured by longer mixing than 40 revolutions, provided the mix remained workable. Mixes that were retempered with additional water to improve the workability after protracted mixing had a strength corresponding to a water-cement ratio that included the added water. The water-cement-ratio-strength relationship appeared to hold as true for truck-mixed as for plant-mixed concrete. While all of Mr. Hollister's 28-day strength results were above Abrams' A-curve ($S = 14000/7^x$ where x is the water-cement ratio), this can hardly be taken as an indication of the superiority of truck-mixed over plant-mixed concrete. Abrams' curve is the average of thousands of tests, and most curves for a specific job lie above it.

An important feature of truck mixers is, according to Mr. Chapman, the opportunity they afford for "conditioning" the concrete. If density be assumed to be indicative of high quality in strength, impermeability, etc., truck mixing should improve concrete, for the longer available mixing time can be utilized to permit and force the escape of entrained air, thus conditioning and making the concrete more dense. The ordinary concrete mixer, designed to secure a maximum of intimate mixing in a minimum of time can hardly be notable for its de-aerating qualities, in Mr. Chapman's opinion. On the other hand, recent studies of the Clinton mixer (a cylindrical drum with narrow spiral blades) in which plant-mixed concrete was placed and agitated quietly and free from turbulence, convince him that such concrete is increased in uniformity and density by the removal of entrained air. He questioned whether this could be expected in a mixer in which the mixing action was violent. He also called attention to the considerable increase in strength with increase in time of agitation and conditioning obtained by the late W. A. Slater, using a smooth-drum type of Clinton mixer. This increase in strength from the time of placing the concrete in the drum until the end of a 2½-hour agitating period was nearly 80 per cent for the 7-, 14- and 28-day tests. In reply, Mr. Hollister stated his belief that 40 turns of the mixer be used had

brought the concrete to a strength comparable to that obtained by Slater in 2½ hours, that his concrete as measured by the Dunagan uniformity test, contained no harmful amount of air and that the desirable kneading action in which all parts of the mass are brought to the surface is obtained in the Jaeger mixer. Lion Gardiner (Lakewood Engineering Co.) concurred in Mr. Hollister's statements. In regard to the relative performance of truck mixers and agitators, A. A. Levison (Blaw Knox Co.) pointed out that truck mixers with blades have three possible uses—original mixing, additional mixing to that received in a plant mixer, and agitation. By varying the speed any desired result should be obtainable, although in his opinion long mixing with any type of truck mixer should not be counted upon to produce increased strength. He reported a test on a truck mixer different from either the Jaeger or Clinton that had shown increase in strength up to 12 per cent for seven hours of mixing but that the mix had zero slump as compared with a 6-in. slump when put in the truck mixer. Another discussion referred to experience in Philadelphia, where premixing 45 sec. plus a 15-min. run in an open-top agitator body, in which the blades revolved at 4 r.p.m., gave good results and improved both uniformity and strength of the concrete. A speed of 6 to 7 r.p.m. was found to cause the maximum stiffening of the mix.

Steam curing

High-pressure steam curing of 3x16-in. cylinders experimented with at the Lehigh Portland Cement Co. laboratory yielded results that are substantially in agreement with previous tests. A definite increase in strength is obtained up to pressures of at least 150 lb. per sq.in. Equivalent strengths may be obtained by subjecting specimens to a high pressure for a short time or to a low pressure for a long time, although it seems best to use a pressure of at least 100 lb. per sq.in. After 42 hours of curing there is little increase in strength regardless of pressure. An important conclusion was that accepted ideas regarding richness of mix and water-cement ratio are not applicable when steam curing is utilized. A minimum water-cement ratio of 0.6 was recommended. Also a space-cement ratio of at least 2.25 was found to be desirable to permit necessary volume change in the specimens without injury. Aggregate types, too, require careful selection when steam curing is to be used. Carbonate aggregates, particularly, do not give good results.

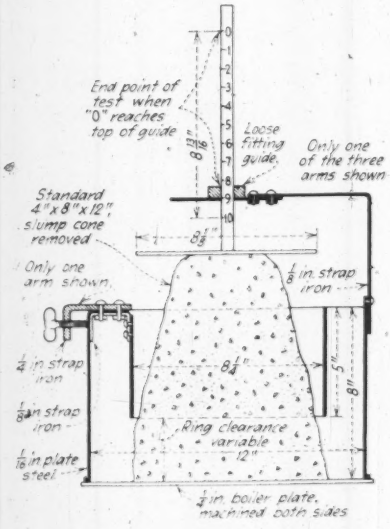
A paper on colored cast stone in which, by pigmentation, various shades of red, yellow and green are obtained, was presented by Fred R. Lear, of Syracuse University. Architects should consider color in connection with mass when proportioning their buildings instead of determining the masses and then adding color, according to Prof. Lear.

Volume change in mortars

Volumetric changes in neat cement and mortar specimens (beams 2 in. square and 24 in. long) begun in 1924 at Purdue University were reported by R. E. Mills. Temperature was controlled or corrected for so that all volume change was due to moisture alone. All neat cement specimens contract or expand consistently with humidity changes, submersed specimens changing about half as much as those exposed to air. During the seven-year observation period there has occurred a net expansion or permanent growth on all specimens. During a single saturation period, from maximum humidity to maximum dryness, portland cement mortars exhibit a net contraction; lime cement mortars show a net expansion, greater for the greater concentrations of lime. While these volume changes tend to disappear, they are continuing to date.

Workability studies

A new workability test for concrete involving the concept of "remolding" or change in shape of a mass of concrete, in this instance by jigging on a flow table, was given in a paper by T. C. Powers, of the Portland Cement Association, and presented by F. R. McMillan. The necessary apparatus is shown in the accompanying illustration. The ordinary slump cone is used to mold the mass, after which the flow table is operated until the mass is "remolded" to a cylindrical shape with its top slightly above the bottom of the inner ring. The number of jigs necessary to complete the change is taken as the "molding effort," believed by the author to give a fair indication of the "placing effort" that would be necessary in the field.



Apparatus for a new workability test in which the effort (jigs of a flow table) to charge the concrete mass from a cone to a short cylinder is taken as a measure of the placing effort required in the field.

In his concept of workability and the factors that influence it, Mr. Powers came to several interesting conclusions: (1) a workable mix is one in which the solids are suspended in an enveloping body of water; (2) the efficiency of this plastic or fluid mass is measured by "its mobility and cohesiveness," in other word by its ease of placement without segregation; (3) both the quantity and the consistency of the paste and the characteristics of the aggregates affect this efficiency. Except in harsh mixtures where particle interference is extreme Mr. Powers' tests showed that molding effort decreases with a decrease in sand content (to a certain optimum value after which the predominance of larger aggregate particles cause interference and again increase molding effort) and an increase in water, that it also decreases with an increase in paste content of the concrete and that it is assisted by using as few a number of sizes of aggregate as possible.

In discussion, George A. Smith (Johns-Manville Corp.) showed workability test curves obtained with a penetration type of apparatus that were in unusually close agreement with Mr. Powers' molding-effort curves, a remarkable coincidence in view of the widely different methods of test and perhaps a significant one in view of the use of penetration test methods for at least ten years past. Other curves shown by Mr. Smith exhibited the marked differences in workability contributed by various admixtures. Mr. Smith felt that Mr. Powers minimized the effect of type of materials on workability, asserting that it was quite as important as consistency and quantity of paste. P. H. Bates (Bureau of Standards) agreed in this and took exception to Mr. Powers' characterization of concrete as a suspension of aggregates in water, stating that the reverse is probably more nearly true. Mr. Bates also questioned whether lack of a good workability test in the past has seriously hampered the development of the concrete art as some discussions of the subject have seemed to imply. R. B. Young, Toronto, stated that Mr. Powers' results check studies he has made with entirely different methods of test. In reply to the various discussions Mr. McMillan stated that results showing unusual workability contributed by use of admixtures are of no value if the concrete so tested lacks the more important attributes of strength and durability.

Allied somewhat to workability is the subject of vibration of the concrete mass in placing. Vibration does not improve quality of concrete more than good spading, although it may effect the improvement more economically by a reduced labor charge, in the opinion of R. F. Leftwich, Raymond Concrete Pile Co., who presented a committee report on the subject. Vibration, on the other

hand, probably does improve bond with steel appreciably. Vibrating the outside of forms punishes them too severely to be a useful and economical expedient, in Mr. Leftwich's experience. Two vibrating machines with arms 5 or 6 ft. long that are buried in the concrete and thus transmit a vibratory effect somewhat more widely than surface vibrators were described as having been used on some Pacific Coast work and also experimentally at the University of California.

Construction work described

Several papers were devoted to specific projects, some of which have been described in *Engineering News-Record* previously, such as the Allegheny County concrete arches Sept. 25, 1930, p. 482, and April 23, 1931, p. 681, and the Mount Vernon memorial highway, July 23, 1931, p. 124. The design features of the latter were presented by R. E. Toms, principal highway engineer, and the construction procedure by J. W. Johnson, district engineer, both of the Bureau of Public Roards. The construction of the Allegheny County arches was described by V. R. Covell, chief engineer, bureau of bridges.

The extensive hydro-power development at Chats Falls on the Ottawa River on the boundary line between the provinces of Ontario and Quebec was discussed by H. L. Trotter, consulting engineer, Montreal. The concrete gravity section dam, 11,000 ft. long with an average height of 25 ft., together with power house, headworks, tailrace, etc., to develop 220,000 hp. in eight units makes the project a notable one. All concrete was mixed in a central plant and elaborate rail transportation facilities had to be provided. Much of the concrete was poured in the winter. Careful check on the work indicated that wood forms provide adequate protection down to the freezing point. Experience, based on special tests, showed that tarpaulins furnishing a dead air space outside the forms are suitable for temperatures between 20 and 32 deg. Below 20 deg. unit heaters were installed under a tarpaulin inclosure. This heat was applied for a minimum of 72 hours, with constant sprinkling as a necessary adjunct. Continuous pouring was exclusively used, with the result that no horizontal construction joints exist on the work. Some pouring periods were as long as 30 hours. An unusually complete installation of automatic recording instruments was used in the central plant, the charts giving time of mix, showing all delays and, by means of power consumption curves, giving an indication of the degree to which each batch was mixed.

Exposed aggregate sidewalks as used extensively in the new landscaping of the grounds of the Capitol in Washington were described by L. F. Dieterich, superintendent of construction, in a paper prepared by H. D. Rouser, assistant architect of the Capitol.

Early Mississippi Flood Stages Not Alarming

Present stages compared with those of 1929 and with maximum probable flood show ample safety margin

By Brig. Gen. T. H. Jackson
President, Mississippi River Commission, Vicksburg, Miss.

FOLLOWING the exceptionally low-water stages on the Mississippi River and its tributaries in 1930 and 1931, the more normal winter stages of 1932 have aroused more inquiry than is usual as to possible threat of overflow and the position in which control agencies are to meet high stages. Concern has also been increased by the reports of flood fighting and levee breaks on adjacent valley streams and some of the lower tributaries of the Mississippi. To enable engineers to appraise the situation a statement has been secured from the Mississippi River Commission of present and predicted water stages for 1932 compared with those of the high water of 1929 and the maximum probable flood stages for which the flood-control works of the present project are designed. With the exception of the great flood of 1927, the valley waters of 1929 reached the highest levels of many years. —EDITOR.

THE Mississippi River is now in flood state, but no apprehension is felt, over stages now in sight. The crest of the flood passed Cairo on Feb. 15 and was passing Vicksburg on Feb. 29. The accompanying tabulation shows flood stages; the actual or predicted crests of the present flood as compared with those of 1929, and of the maximum probable flood against which the present flood-control project is designed to afford protection:

The 1929 flood was successfully held without any crevasses on the Mississippi River. This was done after only one year's construction work had been accomplished after the 1927 flood. Since that time substantial progress has been made on the flood-control project. There is no reason to apprehend any damage whatsoever to the main river levee system from river stages now in sight.

The recent severe flood stages which have occurred on the lower tributaries of the Mississippi have been in general occasioned by severe rainfall within their basins. In some cases flood stages on these tributaries exceeded previous records. Where the levee lines on these tributaries were sufficiently substantial, they have been held by the local interests with the assistance of the U. S. engineer department. Disastrous flooding occurred only where no levees existed or where the existing levee lines were obviously too weak to hold.

	1932 Water Stages			Flood of 1929		
	Flood Stage, Ft.	Crest (Actual or Predicted), Ft.	Date	Crest Stage, Ft.	Date	Maximum Probable Flood, Ft.
Cairo	45	49.2	Feb. 15	52.7	May 19	59.0
Memphis	35	38.7	Feb. 19	41.5	May 22	53.4
Helena	44	49.2	Feb. 22	52.6	May 28	65.4
Arkansas City	48	53.4	Feb. 25	58.8	May 29	62.5
Vicksburg	45	51.9	Feb. 29	55.2	June 6	60.0
Natchez	46	52.5	Mar. 2	54.5	June 5	60.0
Angola	45	52.5	Mar. 5	52.4	June 8	50.5
New Orleans	17.0	20.0	Mar. 9	20.0	June 8	20.0

The weather has generally cleared throughout the lower valley during the past week (Feb. 29). Fair weather is predicted and no heavy rains are at present in sight. Under these conditions falling flood stages on the tributaries are to be expected.

Antwerp Tunnels Progressing

The work of constructing the vehicle tunnel and the pedestrian tunnel in Antwerp, Belgium, under the River Schelde (*ENR*, June 18, 1931, p. 1003) is progressing very satisfactorily. The vehicle tunnel has a total length between portals of 5,800 ft. It has sections at each end of concrete built in open cut, and a central section, 4,428 ft. long, of cast iron lined with concrete. This section is to be shield-driven. It will have an outside diameter of 30 ft. The pedestrian tunnel, an independent structure, also is to be of cast iron lined with concrete and will have an outside diameter of 17 ft. 8½ in. It is only 1,876 ft. long, being reached by escalators in shafts close to the waterfront.

The excavation for the open-cut portion of the vehicular tunnel on the left bank is finished; the concrete work for that portion of the tunnel that is being built in open cut is well advanced. The compressor plant and hydraulic equipment for the shield were completed in November, and the first shove took place Nov. 9. The hydraulic equipment for the shield was manufactured in this country by Watson-Stillman.

For six weeks the shield operation was conducted without air pressure, and about 92 cast-iron rings were erected during this period. Upon the completion of the air bulkhead and locks, work was resumed on Jan. 25, 1932, under air pressure.

In addition to the tunnel work, the ventilation shafts on either end are being sunk by freezing.

The only work so far done on the pedestrian tunnel is the recently completed freezing of the shafts on either bank.

These tunnels are being built by the firm of Pieux Franki, of Liége. Parsons, Klapp, Brinckerhoff & Douglas, and Ole Singstad, of New York, are consulting engineers.

Hollow Concrete Piles Made by Centrifugal Process

Dense concrete of high compressive strength obtained by spinning piles for fifteen minutes

By L. R. Need
Westinghouse Electric & Manufacturing Co., Cleveland, Ohio

ALONG with the development of centrifugally cast concrete street-lighting standards, trolley and distribution poles, the Westinghouse Electric & Manufacturing Co., produced a hollow reinforced-concrete pile made by the same method. More than 3,500 of these piles, totaling 119,000 ft. in length, were used in the construction of 1.6 miles of elevated-railroad approach to the McKinley Bridge in St. Louis for the St. Louis Electric Railroad Co. The piles were all precast at the Westinghouse plant in St. Louis and trucked to the job. In the casting process the piles were rapidly rotated for 15 min., resulting in the concrete being concentrated in the outer part of the cylinder and leaving a smooth central hole filled with excess water from the mix. Details of manufacture and results of tests are given in the following.

The piles varied from 20 to 40 ft. in length. Most of them were driven to rock, the remainder to a safe bearing load of 30 tons, determined by the *Engineering News* formula. The piledriving equipment consisted of a steam crane mounted on crawlers carrying hanging leads and a 5,000-lb. single-acting hammer. During driving, the tops of the piles were protected by a wood and matting cushion under the anvil block of the hammer.

Manufacture

Forms for manufacture of the piles were built in 5-ft. sections of cast steel, split longitudinally. A few halves of the sections and the adjoining sections were bolted together. All of the piles were made with a taper of ¼ in. per foot. The forms were well oiled to insure easy removal.

Forms for half the pile work were bolted together. Then a reinforcing cage, consisting of lognitudinal bars surrounded by spiral wrapping of steel wire, was placed in this part of the mold and securely held by spacers of non-corrosive metal. The other half of the form was then bolted in position, and the entire assembly was taken to the filling pit.

CHARACTERISTICS OF VARIOUS LENGTHS OF CENTRIFUGALLY CAST PILES

Lgth., Ft.	Tip Dia., In.	Butt Dia., In.	No. Long Reinf. Rods	Dia. Rods	Wall Thick. at Butt	Wall Thick. at Tip	Wt., Lb.
20	7	12	6	½	3	2	1,300
20	8¼	13½	6	½	3	2½	1,700
20	9½	14½	6	½	3	3	2,200
25	7	13½	6	½	3	2	2,100
25	8¼	14½	6	½	3	2½	2,500
25	9½	15½	6	½	3	3	2,950
30	7	14½	6	½	3	2	2,650
30	8¼	15½	6	½	3	2½	3,200
35	7	15½	6	½	3	2	3,500
35	8¼	17	6	½	3	2½	4,000

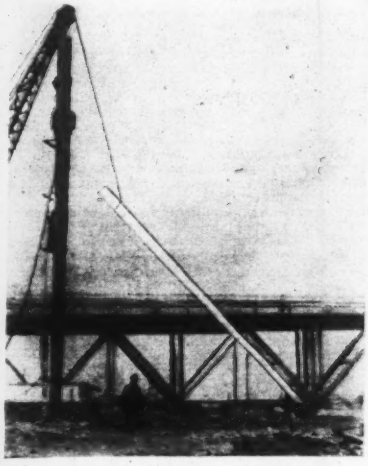


Fig. 1—Centrifugally cast hollow concrete piles may be handled in driver by single line.

The forms were set on end in the filling pit and filled from a standard concrete mixer. End plates were then bolted on, and the filled forms were placed in horizontal position in a spinning lathe. This lathe consisted of a driving end, driven by an electric motor, a tailstock and a series of follow rests on which the mold revolves. Spinning was started at low speeds and accelerated to a maximum of 500 r.p.m. This was continued for 15 min. Centrifugal force acting on the concrete forced it away from the center of the mold and compressed it against the inside surface, forming a very dense concrete free from voids. As a result of the centrifugal action, a longitudinal hole was formed in the center of the pile, which contained the excess water and finer particles of cement that were squeezed from the concrete during spinning. After spinning, plugs were removed at both ends of the mold and the excess water was drained off.

After removal of water the mold was placed in a hot-water bath having a temperature of 175 deg. F. for a curing period of three hours, after which the mold was stripped from the pile and returned to the assembly room. The completed piles, then sufficiently cured for for handling, were sent to the hydrating bay for further curing in a saturated atmosphere for 28 days. At the end of this second curing period the pile was ready for shipment. After 28 days the piles were strong enough to be handled without the use of slings or a strongback.

Fig. 2—Hollow concrete piles are driven with ordinary cast-iron pile cap.

Development and tests

During the development of this type of pile there were many manufacturing difficulties encountered which required careful study, thorough investigation and extensive testing before the pile was considered ready for practical use. Both laboratory and field tests were conducted in the preliminary investigations. Several piles were tested for compression strength at the University of Illinois and at Carnegie Institute of Technology. At the latter laboratory the piles tested were stock piles that had

Fig. 3—Butt ends withstand shock of driving to refusal without spalling or shattering.

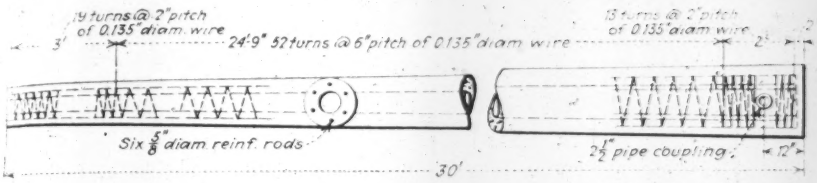

19 turns @ 2" pitch of 0.135" diam. wire
24'-9" 52 turns @ 6" pitch of 0.135" diam. wire
13 turns @ 2" pitch of 0.135" diam. wire
3'
2'
2'
Six ⅝" diam. reinf. rods
2½" pipe coupling
2"
30'

Fig. 4—Reinforcing details for 30-ft. hollow concrete pile.

been driven to refusal, then withdrawn and removed to the testing machine.

Further tests were made to determine the friction bearing of the piles, using a 28-ft. pile with a 7-in. point. This pile was driven to a penetration of 26½ ft., and then successive weights were added until a load of 60 tons was carried. Readings indicated a settlement of ¾ in. at 30 tons load and ⅞ in. at 60 tons.

High compressive strength results from the consolidation of the concrete and the removal of excess water from the mix during manufacture. An average strength of 5,000 lb. per sq.in. was secured. A recent test for the Erie Railroad on a 6x12-in. cylinder and a short section cut from a stock pile showed strength of 6,200 and 6,800 lb., respectively.

Piles manufactured by the centrifugal process, because of the density of concrete obtained by this method, stand the shock of driving, both at butt and tip ends, exceedingly well, and for the same reason they resist action of sea water. The center hole permits jetting from the inside if desired. The piles have a high bearing value for their size and weight. The hollow center and dense concrete gives a lighter pile capable of withstanding shipping and handling shocks.

At present the piles are manufactured at the St. Louis works of the Westinghouse Co., but they will be made at several other main plants for shipment to many parts of the country.

Letters to the Editor

Cantilever Concrete Bridge Cost

Sir—In your issue of Jan. 28, 1932, D. B. Steinman contests my statement that the reinforced-concrete cantilever bridge at Montrose in Scotland is more economical than structural steel. If he had only written the penultimate paragraph of his letter stating that given the necessary information American bridge engineers are prepared to disprove my claim, that would be reasonable except I think he might have said that they would "attempt" to disprove. He would seem to constitute himself and his brother engineers as judges already prejudiced. I am surprised that he should insert this paragraph, as in the remaining paragraphs he makes sweeping statements that would be justified only if he had disproved the claim, which he admits in the penultimate paragraph he cannot do without further information.

For the interest of those who may have been misled by his letter, the following table gives the various loads split up into percentages of the total causing bending moments:

	Per Cent
Live load plus impact	32
Paving, road works and pipe trough	16
Parapets	7
Decking with cross-members	27
Main truss members	18
	100

Mr. Steinman makes the statement that with structural steel, owing to a reduced dead load, the top boom could be reduced 40 per cent. The foregoing tabulation shows how ill-founded Mr. Steinman's statement is. He also uses the phrase, "The use of reinforced concrete for tension members is illogical and obviously wasteful." The purpose of reinforced concrete is to make it useful for tension members and it is not wasteful, as the concrete replaces rivets at a cost surprisingly low, as a few figures will disclose. In any case the cost of reinforcement is considerably less per ton than structural steel and more than offsets the slightly greater area required. Why does Mr. Steinman not remember that a cantilever has a compression boom as well as a tension boom? In the reinforced-concrete cantilever bridge the decking is the compression boom—that is, the cost of a compression boom is practically nil, as the decking must be there in any case.

I would vary Mr. Steinman's statement into "the use of structural steel for compression members is illogical and obviously wasteful," particularly when compression material in the way of concrete is there in any case.

Mr. Steinman makes another statement: "The dead load alone is nearly trebled." I fail to see how a structural steel design if at all economical could materially reduce the dead load, as only 27 per cent of the dead load is in the trusses. No doubt he may argue that the decking and crossbeams are heavy. They are certainly cheaper than could be done in steel to meet the same conditions and to an extent that would not be met by the saving of a fraction of the area of the top boom. There is not as much money in this top boom steel as Mr. Steinman seems to imagine, as he can easily work out himself from the number of square inches and the length of the bridge.

The sweeping statement of a possibility of 30 per cent saving in foundations is obviously wrong from the foregoing tabulated statement, nor would I subscribe to the view that the cost of the substructure is directly proportionate to dead load. It may interest your readers that this bridge was in competition with a steel design, which it defeated in spite of all the considerations set out in the last paragraph of Mr. Steinman's letter.

To conclude, I would say that until Mr. Steinman were in a position to discuss the project thoroughly, which in his penultimate paragraph he admits he is not, he has no right to use the adjectives he does, nor to conclude with the last clause of his letter. At any rate it is not engineering.

London, England, Feb. 11, 1932. E. OWEN WILLIAMS.

* * *

Sir—Referring to the above letter from Sir E. Owen Williams, I believe it is a fair and adequate response simply to repeat my previous invitation to him to submit stress and section sheets, quantities and unit costs, so that more conclusive comparisons can be made. Until he accepts this challenge, I cannot go beyond my previously published notes to show that his claim of superior economy for a cantilever truss bridge of concrete does not appear plausible.

Mr. Williams takes exception to my reference to fitness, tradition and esthetics, on the grounds that "it is not engineering." These may not be engineering in the strictly technical sense, but any bridge designer who disregards these considerations is not fulfilling his professional obligation.

New York City, March 7, 1932. D. B. STEINMAN.

Freyssinet Arch Construction

Sir — Theory of the Freyssinet method of concrete-arch construction described by C. B. McCullough and A. L. Gemeny in your issue of Nov. 26, 1931, is simple; however, its application involves many uncertainties in assuming the physical properties of concrete.

The modulus of elasticity of concrete is not constant, since it varies with the mixture and method of pouring and also with time and loading. In the concrete arch of the Conflans-Fin-d'Oise bridge the modulus of elasticity, as determined from tests after completion of the bridge, was 60 per cent higher than

had been assumed in the computations.

From the tests of concrete arches in the laboratory of the University of Illinois Prof. Wilbur M. Wilson showed that the modulus of elasticity for the same arch varied as much as 60 per cent.

More difficulties occur in assuming the amount of concrete shrinkage. It varies with the nature of the cement and aggregate, with the mixture of concrete and with the temperature of the atmosphere. Therefore, in the Albert Louppe (Plougastel) bridge, regardless of the fact that the Freyssinet method of prestressing of arches was adopted, the arch ribs were cast in blocks to decrease the effect of the setting shrinkage of concrete.

The undesirable stresses due to shortening of the arch and shrinkage in concrete cannot be fully eliminated. However, the Freyssinet method makes it possible to introduce in the arch a most satisfactory distribution of the maximum combined stresses computed from the assumed loading, physical properties of concrete and foundation material, and climatic conditions at the site.

A. A. EREMIN,
Assistant Design Engineer, Bridge Department, State Highway Commission.

Sacramento, Calif.
Feb. 10, 1932.

Highway Traffic Accidents

Sir—I note that on page 323 of the March 3 issue of *Engineering News-Record*, in my article entitled, "Highway Engineering and Its Relation to Traffic Accidents," in the thirteenth line of the first column there is an error. As printed, the article states that for secondary roads the sight distance should not be less than 40 ft. This should be 400 ft.

I am calling this to your attention as some reader may be confused by this error.

HARRY TUCKER,
Professor of Highway Engineering, North Carolina State College.

Raleigh, N. C.,
March 3, 1932.

Unemployment and Public Works

Sir—In making up data for my annual report of the city of Chicopee, I discovered the following facts which may interest you as a concrete example of the expenditure of large sums of money, with only a fraction due the white collar and laboring man, in the strain to benefit them in maintaining their own self-respect. The letter quoted is one which I sent to our Representative in Washington, William G. Granfield, of Springfield, Mass.

Since the recent meeting of Congress we hear of various bills introduced of from two to five billions of dollars as a cure for unemployment. This would be expended for labor and material in construction of works of public character, particularly in the line of new highways.

In the last year this city has expended about $800,000 in building an extension to the waterworks and a concrete bridge across Chicopee River, which cost about $200,000 each; new highways and sewers costing $300,000, and two highways by the county and state costing nearly $100,000.

In the case of the city, about $150,000 was expended in actual labor. In building the bridge, machinery was used as far as possible, but of course there were carpenters and laborers, some of whom were of local residence and our unemployment benefited. Less than $200,000 out of $800,000 came back to Chicopee labor.

In the two sections of state highway something over 3 miles in extent labor was performed almost entirely by machinery. Short sections of drain pipe were laid at 15c. a foot and of course that was a small item in the total. In both the bridge and the state highway our local labor has benefited to a very small extent.

I am wondering where the unemployment of the country would gain by the expenditure of billions of dollars unless the requirement was made that manual labor should be employed in all these schemes.

Anyone attending the American Road Builders' Association show, either at Detroit or at other places, would wonder where the manual labor came in. The labor displaced by the mechanization in industry is a serious problem in itself which is rendered still more serious in present depression.

In these days when the word moratorium is being worked to death, one additional method, it seems to me, will be to declare one on machinery in the building of highways, say for one year.

In our city of Chicopee we have been unfortunate in losing one of the largest corporations, the Dwight Manufacturing Co. It formerly employed about 2,500. It is now owned by the Pierpont Morgan Co. and has been moved bodily from the city. But none of the help has moved, and that formed a good proportion of our unemployed class, which last year helped to strain our finances over $300,000, about four times what we paid three or four years ago.

Our tax rate climbed to $39.50 last year. Our welfare department has probably boosted the tax rate about $7 per thousand. We are faced with a possible tax rate of $42 per thousand and the demand upon the assessors will again lessen our valuation by probably $1,000,000, reducing it from $51,000,000, or more in 1929 to $46,000,000 this year.

If this letter merits discussion, I shall be very glad to hear what may be said on the subject.

F. P. COBB,
City Engineer.

Chicopee, Mass.,
Feb. 18, 1932.

Money for Rural Roads

Sir—Permit me to comment upon the contribution of R. C. Fulbright in *Engineering News-Record*, Feb. 25, 1932, p. 284. In your editorial preface to this article you speak of "the flood of misstatement and perversion of facts relating to the source and kind of current road building funds." Apparently your correspondent relies entirely on information compiled by the U. S. Bureau of Public Roads. Naturally, like other government bureaus and departments, the Bureau of Public Roads is interested, first of all, in self-preservation.

I submit that your writer has stated only a part of the picture. In order to ascertain whether or not transportation by public highway is solvent or not, should state not only the revenue [illegible] an entire income account, which [illegible] cludes maintenance as a part of oper[illegible] ting expense and depreciation, includi[illegible] inadequacy and obsolescence. He shou[illegible] also set up a balance sheet in much t[illegible] same fashion as required of the ra[illegible] roads by the Interstate Commerce Co[illegible] mission to ascertain the profit and l[illegible] balance.

I agree with you that there has been [illegible] flood of facts, but whether they a[illegible] misstated or perverted cannot be dete[illegible] mined by Mr. Fulbright's article.

W. M. HOOV[illegible]

Toledo, Ohio.
Feb. 29, 1932.

* * *

Sir—My attention has been called t[illegible] an article in *Engineering News-Record* of Feb. 25, 1932, p. 284, by R. C. Fulbright, in which he says: "There was once a law in Ohio which permitted assessments to be made against abutting property for the improvement of state roads. The information is that this law has been repealed."

Mr. Fulbright is mistaken in this statement, as Sec. 1214 G. C., permits the assessment of the costs of state highways above 20 ft. in width against adjoining or abutting land. Under this section of law grave offenses have been committed under the guise of "assessments for benefits received," when in reality the adjoining and abutting land was damaged and partly or wholly confiscated.

C. A. DYER,
Columbus, Ohio, Ohio Farm Bureau Federation.

March 2, 1932.

* * *

Sir—I have been very much interested in the article entitled "Where the Money for Rural Roads Comes From." At the meetings of the Chamber of Commerce of the United States and also at the meetings of the International Chamber of Commerce last summer figures similar to these, were presented by the highway proponents tending to show that the railways paid little or nothing toward the costs of highway construction. Other figures, apparently equally authentic and equally convincing, presented by railway representatives, showed that the railways were shouldering a large part of this cost.

As it stands, Mr. Fullbright's article is very convincing, but I think there is another side to the argument and it would be interesting to have the view of the railways or their interpretation of the figures to compare with this.

There is a great deal of misunderstanding in this matter and apparently ex parte interpretations which are misleading. The *Engineering News-Record* would, I believe, be doing an excellent service if it could present both sides and a final weighing of the merits of the case.

F. LAVIS.

New York, N. Y.,
March 2, 1932.

NEWS OF THE WEEK

Amendment Proposed to Bacon-Davis Wage Law

The Bacon-Davis law, in force since March 3, 1931, requiring the payment of prevailing wages on federal building work, would be considerably amended and extended to include all federal construction contracts in excess of $5,000 by measures proposed by Senator Metcalf (Senate bill 3847). The wages to be paid, determined in advance by the secretary of labor, would be stipulated in advertisements for bids. The wage scales might be changed from time to time by the department of labor if deemed advisable, after a petition by twenty workers or the contracting officer on the project. Any change in scales would change the status of contract payments in favor of the government or the contractor, according to the direction of change. Definite penalty in the forms of fines is provided for each violation of the act, including the practice of requiring employees to rebate part of their wages. The act would include government day-labor work.

50-Year Plan for Philadelphia Tri-State Region

A regional plan for the guidance of the Philadelphia tri-state district during the next half century, evolved after years of work by more than 200 engineering officials and consulting architects in the 4,555 square mile area embracing parts of Pennsylvania, New Jersey and Delaware, will be presented by the Regional Planning Federation at a dinner in Philadelphia on March 16.

The federation, headed by Samuel Price Wetherill, Jr., of Philadelphia, has studied the probable distribution of population in the district up to 1980. Its plan will outline a system of major and secondary highways, boulevards, parkways and bridges, and will suggest further development of railway passenger and freight transportation facilities, waterways and ports, systems of airways, landing fields and parks, sanitation, drainage and water-supply facilities.

A.G.C. and Steel Institute Cooperate to Stop Bid Peddling

In an effort to rid the construction industry of the disastrous practice of bid peddling, the Associated General Contractors has appointed a committee of three to confer with a like committee of the American Institute of Steel Construction. Representing the contractors on the committee will be W. G. Luce, Hegeman-Harris Co., New York; M. B. Markland, M. B. Markland Co., Atlantic City, and William Steele III, Philadelphia. Those appointed to act for the Institute are R. T. Brooks, George A. Just Co., New York; A. J. Post, Post & McCord, New York; and H. B. Hirsch, Belmont Iron Works, Philadelphia.

Drain Bonds Void, Declares Michigan Supreme Court

BY TWO decisions of the Michigan supreme court, certain drain bonds of Oakland and Macomb counties, totaling more than $5,000,000, have been declared invalid because they were used to build sewers. The two sewers concerned are the Nine-Mile Halfway sewer in Macomb County and the Southfield storm sewer, in Wayne County. William Manning, head of the municipal bonds division of the state treasury, declares that several other issues in both counties will be invalidated by the court's ruling, among them, he believes, the Royal Oak drain bonds, upon which no interest has been paid pending the court's decision.

The court stated specifically that the drain commission is without authority to construct sewers from the proceeds of securities issued for the purpose of financing drains. The court held that at the time the securities were sold the law prohibited the use of money obtained from sale of drain securities for sewer construction. An effort was made by the last legislature to remedy this by a law permitting such use, but this act is not retroactive. Bondholders are expected to sue the counties for the return of their money.

The Nine-Mile sewer and disposal plant was started in 1925 and is 7½ miles long. It cost $2,338,835. The Southfield trunk sewer, which was to take care of sewage from southern Oakland County, was started in 1928, and on Sept. 29 of that year work was halted by a suit brought by a number of property owners (*ENR*, Dec. 4, 1930, p. 897). Bonds aggregating $2,730,000 issued and sold to pay for this sewer were declared invalid by the Michigan circuit court in November, 1930, and this decision is now upheld by the supreme court.

Texas Governor Warns Against County Road Bond Issues

Gov. Sterling has issued a warning to the counties of Texas not to issue any more road bonds because of the fact that the people are already overburdened with taxes.

"My attention has been called by the highway department to the fact that various counties in Texas still are voting or contemplate voting bonds for the construction of state highways," the governor says. "It is my opinion that no county should burden its taxpayers by voting bonds for such a purpose. I have always maintained that the homes, farms, ranches and other real estate should not be called on to build state and federal highways. I am still of the opinion that the counties should be refunded the money they have placed in state highways and that their outstanding bonds should be assumed by the state or other bonds issued in lieu thereof."

Personnel and Wage Reductions in Los Angeles

Reduction in personnel to meet an anticipated budget deficit of $750,000 was ordered March 1 by the Los Angeles, Calif., city council in ordinances striking 316 jobs from the city payroll. An estimated saving of $240,000 for the remainder of the fiscal year is expected to be effected. Additional saving is planned through the proposed inauguration of a five-day week for all workers under the council's jurisdiction on weekly and monthly salaries and a sliding scale reduction will be introduced. The scale is 2 per cent reduction for all salaries to $150 per month, 4 per cent from $151 to $200, 6 per cent from $210 to $300, 8 per cent from $301 to $400 and 10 per cent from $410 to $600. The salary of the city engineer will be reduced from $10,000 to $7,200 a year and the positions of chief deputy engineer, at $500 a month, and director of assessments, at $450 a month, will be eliminated.

Sacramento Building Crafts Take Cut in Wages

Twenty-six building crafts in Sacramento, Calif., accepted a voluntary cut in wages ranging from 9 to 20 per cent, effective March 7. The new wage scale will be operative for one year. Included in the new scale are the following reductions:

		Reduced to
Carpenters	$9.00	$8.00
Cement laborers	6.25	5.50
Electrical workers	10.00	8.50
Engineers, hoisting	10.00	8.00
Engineers, structural	11.00	10.00
Reinforced-iron workers	9.00	8.00
Laborers	5.50	5.00
Structural steel workers	11.00	10.00
Truck drivers (per hour)	.742	.682

It is believed this wage cut will stimulate the construction industry and relieve the unemployment situation in the building field. The workers in the building trades are already on a five-day week of eight hours per day, which became effective June 2, 1930.

Bureau of Tests Discontinued in Allegheny County, Pa.

The extensive departmental reorganization that has been under way in Allegheny County, Pa., in which is located the city of Pittsburgh, has taken heavy toll of technical services. The latest and most drastic change includes the discontinuance of the unusually efficient bureau of tests, of which P. J. Freeman has been chief. The first move in the reorganization abolished the department of public works, substituting therefor a department of highways and a department of services and supplies. The bureau of tests was transferred to the latter department and then without warning was abolished altogether. The inspection service that it was rendering on the several million dollars worth of work under way is understood to have

been transferred to a commercial testing laboratory. Mr. Freeman's bureau contained between 30 and 40 men. The bureau of bridges, now in the department of highways, has been maintained intact to date.

New York Engineer Convicted of Practicing Without License

Domenico Briganti, an engineering graduate from an Italian university, has been convicted of violation of the New York education law, which requires that engineers who practice in the state must be licensed. The case was tried before the court of special sessions, county of New York, and the decision was given on Feb. 25, 1932. Subsequently Mr. Briganti was sentenced to imprisonment for 60 days, but the sentence has been suspended, as the state's chief object in pressing the case was to determine the legality of the particular sections of the education law under which Mr. Briganti was prosecuted.

Action was brought under section 1450 of the education law, which provides: "It shall be unlawful for any person to practice or to offer to practice professional engineering or land surveying in this state, unless such person has been duly licensed under the provisions of this article."

Mr. Briganti's defense for offering to practice and for practicing civil engineering without a license was based on the fact that he is in possession of a degree of civil engineering from an Italian university. Because he had this evidence of his training as an engineer he held it was not necessary for him to be licensed to practice; also that possession of the degree gave him the right to use the title civil engineer on his letterhead.

This view was not supported by the court. It held that the holding out of a person, or the mailing of a letter, or the handing out of a card, describing oneself to be a "civil engineer" without first having obtained a license from the state to practice as such is in direct violation of the law.

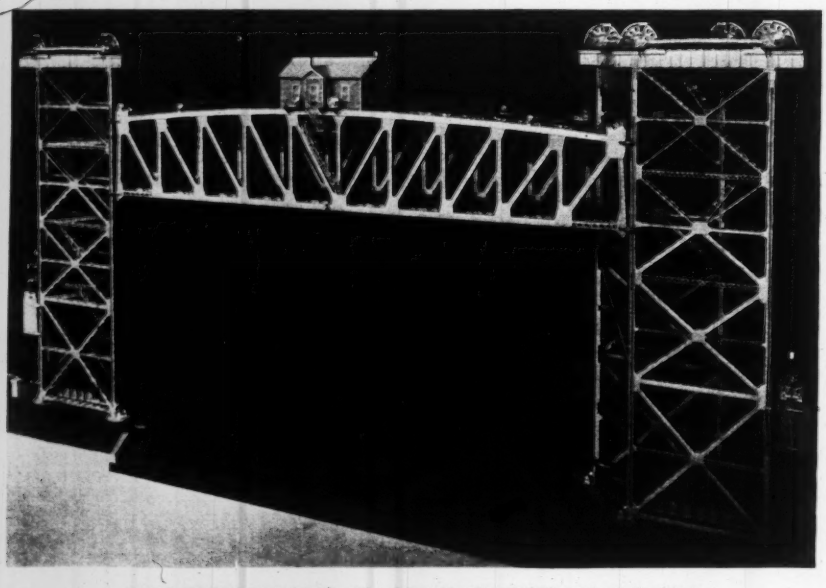
Mr. Briganti's ability as an engineer was not in question; for this reason the decision is considered of special significance by the state enforcement authorities.

New Bids Asked on San Gabriel Dam No. 2

The county board of supervisors of Los Angeles, Calif., has called for new bids on flood-control dam No. 2 in San Gabriel Canyon and has declared forfeited the $168,000 bidder's bond of the Merritt-Chapman & Scott Construction Co., of San Pedro, Calif., for failure to sign the contract after obtaining the job on its low bid. (See *ENR*, Feb. 25, p. 299.) The new bids are to be opened March 21.

The action of the board was taken a day following the filing of a suit in the U. S. district court by the construction company asking the court to annul the bid. The company refused to sign the contract and had petitioned the board to be relieved of the work on the ground that an error had been made in its figures that would cause the company to lose more than $500,000 if compelled to proceed with the job. The bid presented by the company was $1,686,464, about $500,000 lower than the next lowest bid.

The company seeks to be relieved of the work on two general grounds. One is that an honest error was made in figuring the job and that it so notified the supervisors and requested permission to withdraw and was refused. The other ground is that the specifications upon which the bid was made contain the new prevailing-wage law clause, which is open to attack by a taxpayer's suit and which might cause the contract to be declared void.



LIFT BRIDGE MODEL PLACED IN INDUSTRIAL MUSEUM

This model of a vertical lift bridge on the Pennsylvania Railroad over the south branch of the Chicago River, at Chicago, has been placed in the Chicago Museum of Science and Industry. The model is built on a scale of ½ in. to 1 ft. and is about 75 in. long, 16 in. wide and 32 in. high. A specially designed device enables the center lift span to rise to the highest position in 55 seconds, remain there for 6 seconds and then return to its original position. The model was constructed by the Paul F. Hermann Co., Pittsburgh, Pa.

Beauharnois Canal to Be Taken Over by Canadian Government

The canal being constructed by the Beauharnois Corporation between Lake St. Francis and Lake St. Louis is to be conveyed by the company to the dominion government. This provision, contained in an order-in-council passed by the government, specifying the terms, conditions, limitations and reservations upon which the reorganized enterprise will be permitted to divert 53,072 sec.-ft. of water, anticipates the carrying out of the St. Lawrence waterways scheme. It is assumed that the canal will link in with the plan for deepening the St. Lawrence.

Lands and works of the company as may be deemed necessary or useful for the maintenance and improvement of navigation by means of the canal and the maintenance and operation of the canal for navigation purposes are also to be transferred to the dominion. The company will retain title to the power house, forebay and tail-race and other works required for its hydro-electric power development or future extensions, but in no case can there be any interference with navigation in the canal.

In the event that the federal government decides that locks and appurtenant works should be constructed to connect Lake St. Louis with the canal for navigation purposes, the company will convey to the dominion, free of all cost or encumbrance, the title of such of the company's lands as are necessary for locks and works. All bridges over the canal must be provided and maintained by the company. When it is decided to use the canal for navigation purposes, the fixed spans in the bridges must be removed at the expense of the company. The company must also supply, free of charge, the electric power for operating, repairing, lighting and maintaining the canal. The company is given five years in which to complete the project.

California's Water-Conservation Program Taking Shape

Several meetings of the California Water Resources Commission, appointed by Gov. Rolph, and the joint legislative water committee, appointed at the last session of state legislature, have been held during the past few months for the purpose of drafting a proposed amendment to the state constitution to pave the way for the beginning of the projected $373,000,000 water-conservation program of the state. Tentative drafts of the amendment have been agreed upon by both groups, but agreement has not been reached on some of the details of the plan.

A main point of differences between the two groups is that dealing with the state's right to condemn established water rights for future public projects.

Gov. Rolph has called a joint meeting of his water commission and the joint legislative committee to be held in San Francisco March 17, and it is hoped that this meeting will result in an agreement on a final outline of the proposed amendment. The governor has intimated that if an agreement is reached he may call a special session of the legislature to consider the constitutional amendment.

American Toll Bridge Association Organized

The American Toll Bridge Association was organized at a meeting held recently at the office of the Delaware River Joint Commission, Camden, N. J. The purpose of the association is to bring into existence a medium through which ideas of mutual interest and benefit to its members may be interchanged. Committees on traffic, maintenance, accounting, toll-collection systems and insurance will be formed to study and report on matters regarding toll bridge operation, and statistics and tables regarding toll bridges will be compiled and made available for reference. An annual meeting will be held at which the reports of the committees will be presented.

Officers of the association are: president, D. B. Steinman, New York City; vice-presidents, eastern district, Joseph K. Costello, Camden, N. J.; central district, A. C. Shinkle, Cincinnati, Ohio; western district, Oscar H. Klatt, San Francisco, Calif.; secretary, P. K. Schuyler, Washington, D. C.; treasurer, Horace J. Stradley, Camden, N. J.

Minnesota Engineers Hold Two Annual Meetings

Utilization of lumber in modern engineering and architectural work was one of the main subjects presented at the annual meeting of the Minnesota Federation of Architectural and Engineering Societies, recently held at St. Paul, Minn. A paper by I. N. Tate, general manager of the Weyerhaeuser Sales Co., showed that the lumber industry has reached a critical point and must either continue with a gradually reducing output or develop new and increased uses for its product. The timbers of Brazil and their possible uses in this country were reviewed by William T. Cox, of the new state conservation commission.

Developments in Russia were presented by J. R. Stack, consulting engineer, and by Prof. H. G. Zavoral, University of Minnesota.

Taxation of iron ore is becoming so burdensome in Minnesota that only the low cost of lake transportation makes it possible to continue mining, according to E. P. Scallon, mining engineer and member of the state legislature. Safety in iron mining was discussed by A. C. Borgeson, Snyder Mining Co. Laboratory research work was dealt with by H. D. Sanborn, General Electric Co.

There was an attendance of about 200 members and visitors. J. A. Colvin, Northern States Power Co., Minneapolis, was elected president, and W. H. Tusler and Albert Buenger were elected vice-presidents.

At its annual meeting in Minneapolis of the Minnesota Surveyors and Engineers Society, preceding the meeting of the federation, there was a registered attendance of 150. A. S. Milinowski read a paper on "Sewage Disposal for Small Cities," and subdivision of lake beds to eliminate shallow areas that have dried up during the long dry cycle was discussed by F. E. Clark. Prof. L. F. Boon presented a paper on "Art and Science of Measurements." Other subjects included "Use of Treated Timber in Engineering Work," "The Engineer as a Court Witness," "Low-Cost Bituminous Surfaces" and "Comparison of Highway Administration Systems."

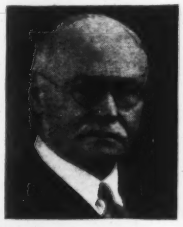
Officers elected include: president, R. T. Campbell, city engineer, Brainerd; vice-president, J. F. O'Mears, state highway department, Redwood Falls; secretary, L. P. Zimmerman, state highway department, St. Paul, Minn.

St. Louis Provides Plaza at Union Station

The surroundings of the St. Louis union station are being improved by the development of a plaza and the widening of Market St. from 60 to 100 ft. The plaza area has been cleared of buildings and will be graded and sodded this year, pending a permanent layout. A 76-ft. roadway in Market St. will also be paved for the two blocks of the station frontage.

Anson Marston Retires as Dean at Iowa State College

Anson Marston, dean of engineering at Iowa State College, Ames, Iowa, will retire from his administrative duties on June 30, and will be succeeded by Prof. T. R. Agg, assistant dean of engineering, according to an announcement recently made by R. M. Hughes, president of the college.



Anson Marston.

Dean Marston has been a member of the faculty of the college of engineering at Iowa State for 40 years and has been dean of engineering for 28 years. He has seen the college of engineering grow from an enrollment of about 200 in 1892 to a peak of 1,900 in 1930-31. He was president of the American Society of Civil Engineers in 1929. At the present time he is a member of the Interoceanic Canal Board, appointed by President Hoover to review the proposed Nicaragua Canal and the plans for enlarging the Panama Canal. Dean Marston will continue to devote all of his time to the college, being actively engaged in completing certain culvert and other engineering research upon which he has been engaged for several years. He will continue to teach courses in engineering valuation for senior and graduate students in engineering.

T. R. Agg.

Dean Agg is an electrical engineering graduate of Iowa State College, class of 1905, but has been professor of highway engineering at the college since 1915. He has made many contributions to the literature on highway engineering, both through text books and through his research for the Iowa Engineering Experiment Station. He has been an active member of the highway research board of the National Research Council.

Oregon Highway Commission Is Reorganized

Internal friction in the Oregon state highway commission has resulted in the resignation of J. C. Ainsworth, of Portland, and William Hanley, of Harney County, and the forced retirement of Charles K. Spaulding, of Salem. The governor has appointed a new commission consisting of Leslie M. Scott, Portland; E. B. Aldrich, Pendleton; Carl G. Washburne, Eugene.

Commissioner Spaulding, whose resignation was asked for, alleged wastefulness in the conduct of the state highway program. He advocated a cut in salaries of the engineering force ranging from 16 per cent downward and a cutting down of the force, including the dismissal of Roy A. Klein, state highway engineer. The other commissioners objected to this, pointing to a 12 per cent saving in administrative expense in 1931 as compared with 1930, and a 17 per cent saving in maintenance expenditures in the same period.

Denver's Water System to Be Electrified

Complete changeover within two years in Denver's municipal water system by displacement of the present steam pumping plants with electrified service is assured by the signing of a contract on March 1 by the water commission and the Public Service Company of Colorado, which will furnish power for the project. Three of the city's pumping plants, now partly electrified by municipal generating plants, are to be supplied with current from company lines by April 1.

The entire program contemplates an expenditure of $1,500,000, to be paid out of earnings. This sum includes more than $1,000,000 for new pipe lines and a retaining reservoir several miles south of Denver, and about $300,000 for installation of machinery, wiring and other equipment incidental to the process of modernizing the system.

C. C. Schrepferman, manager of the water department, estimates that an annual saving of $85,000 will result to the city by the electrification.

Mail Course in Estimating Construction Costs

For the benefit of men interested in preparing estimates of construction costs, a new course has been introduced by the University of Wisconsin extension division at Madison. The course is called "Estimating Construction Costs," and will be offered to students in any state by correspondence study. It is intended for contractors and others doing construction work, estimators, engineers, architects and designers. Topics treated include: transportation and handling of materials; excavation; piling; concrete; wood construction; brick, tile, stone; structural steel; lathing; plastering; roofing, flashing, waterproofing; pipe work and heating; electrical work; painting and glazing; paper hanging; machinery and its erection; overhead; estimating; prices of construction; and construction management.

Phoenix, Ariz., Dedicates New Water System

On Feb. 8 final payment was made on the new water system for Phoenix, Ariz., and on Feb. 22 Mayor Franklin D. Lane, City Manager George H. Todd and City Engineer W. J. Jamieson participated in the dedicatory exercises at the main reservoir site. Construction work had been under way since Dec. 26, 1930. Altogether $2,367,144.82 was spent.

The major construction units were: laying 28 miles of concrete pipe from the Verde River to Phoenix; installation of a complete new cast-iron pipe distribution system within the city; construction of a settling basin at the intake; a new 20,000,000-gal. reservoir in addition to the old 16,000,000-gal. reservoir. The daily delivery capacity is 23,000,000 gal., with a 75-lb. pressure available in the business district.

The general contracts were held by the American Concrete Pipe Co. and the Schmidt-Hitchcock Construction Co., of Phoenix.

Minnesota Construction Industries Organize

More than 500 attended a conference of the allied construction industries of Minnesota held at the Nicollet Hotel in Minneapolis on March 3 for the purpose of organizing the several industries concerned with construction throughout the state of Minnesota.

The conference was called by William H. Ziegler, of the William H. Ziegler Co., of Minneapolis, acting chairman of the ways and means committee, appointed to prepare a plan for permanent organization. In this Mr. Ziegler has been assisted by J. D. Marshall, of the Associated General Contractors of Minnesota, as secretary of the committee, and twenty other representatives of the architects, engineers, general contractors, subcontractors, surety companies and equipment manufacturers and dealers who operate in Minnesota.

The conference was welcomed to Minneapolis by Mayor William A. Anderson and by George Wallace, state tax commissioner, representing the governor of Minnesota, both of whom discussed briefly the public-works situation in the city and the state. The program included brief discussions by the representatives of the various interests as to the value of an integrated construction group to the welfare of the industry and the state. The conference was addressed by Willard Chevalier, publishing director of *Engineering News-Record* and *Construction Methods*.

Resolutions adopted provided for the creation of an organization to be known as the Allied Construction Industries of Minnesota, having as its purpose a closer cooperation among the several elements engaged in construction and the constructive promotion of community welfare as related to the activities of the construction industry. A plan of permanent organization was submitted and approved by the conference to be worked out and established by the ways and means committee.

Simultaneous with the Allied Construction conference the Associated General Contractors of Minnesota held its thirteenth annual convention March 3-5, presided over by D. A. Daly, of Foley Bros., Inc., president of the association.

Plans for Reconstruction of Austin Dam

Plans for reconstruction of the dam on the Colorado River at Austin, Tex., by Austin Dam, Inc., have been filed with the city commission. The estimated cost of restoring the dam, constructing a hydro-electric plant and all other appurtenances, is $1,500,000. The original cost of the dam, much of which is still standing in good condition, was about $2,000,000.

The height of the dam is to be raised to 60 ft., head gates and hoists of modern design will be installed, and the stability of the gravity section of the dam is to be increased by the addition of concrete on the downstream face of the present spillway. Steel crest gates of the fixed-roller type will be installed.

Austin Dam, Inc., has been given until Nov. 30, 1933, to begin construction and until Nov. 30, 1935, to complete the work and place the rehabilitated dam in operation.

Canadian Institute Sponsors Lectures on Concrete

The St. John (N. B.) branch of t Engineering Institute of Canada sp sored a series of lectures every even during the week beginning Feb. 29 on different phases of the making of concr and the handling of cement. The l turer was J. M. Portugais, of Montreal, member of the Institute. Many local c tractors and foremen attended the lectur the aim of which was to give practical a authoritative knowledge on cement a concrete.

Hoover Dam Notes

Work in the diversion tunnels at Hoov Dam again is proceeding rapidly after temporary shutdown due to high wat During the week ended Feb. 27 drivi of 41x56-ft. enlarged headings continu in tunnels Nos. 2 and 4, 206 ft. and 130 f of progress being made, respectivel Progress during the week in removing th remaining 15-ft. bottom bench was as fo lows: tunnel No. 1, 280 ft.; No. 2, 310 ft No. 3, 590 ft., and No. 4, 60 ft. Trimmin preparatory to placing concrete lining wa carried on in three of the tunnels.

* * *

Excavation for the inlet portal of tunnel No. 4 was completed to the top of the diversion tunnel. Preparations were made to start excavation work at the site of the Nevada inlet towers. At the outlet end of tunnel No. 2 the work was confined to the removal of muck deposited by the recent flood. Excavation of the Nevada spillways was continued with two shifts. In the inclined spillway tunnels the 7x10-ft. top headings have progressed 342 ft. in the Nevada tunnel and 169 ft. in the Arizona tunnel.

* * *

Operations at the Arizona gravel pit were carried on with three shifts daily. The material is being screened and piled near the screening plant. Two 4-yd. mixers have been installed recently at the concrete plant.

* * *

Nearly 800 of the 1,200 men temporarily laid off on account of the flood have been put back to work. More than 3,600 men are now employed on project activities.

COSTS AND CONTRACTS

ENR Index Numbers

	Cost			Volume	
March,	**1932**	**157.21**	**Feb.,**	**1932**	**105**
Feb.,	1932	161.82	Jan.,	1932	121
March,	1931	194.51	Feb.,	1931	198
Average,	1931	181.35	Average,	1931	220
Average,	1930	202.85	Average,	1930	260
1913		100.00	1913		100

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week of March 10, with some comparisons, total as follows:

(In Thousands of Dollars)

	Mar. 10, 1932	Average of Last Four Weeks 1932	1931
Buildings:			
Industrial	$687	$845	$4,156
Other	3,545	5,073	14,965
Streets and roads	4,086	3,402	10,319
Other construction	5,914	7,115	12,830
Total	$14,232	$16,435	$42,272

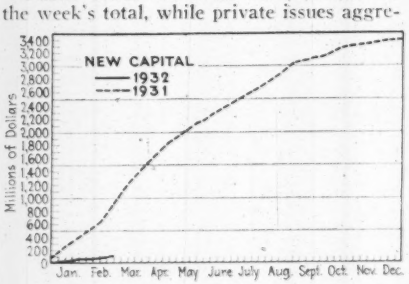
Total, all classes, Jan. 1 to Mar. 10:
1932 ..... $192,449
1931 500,209

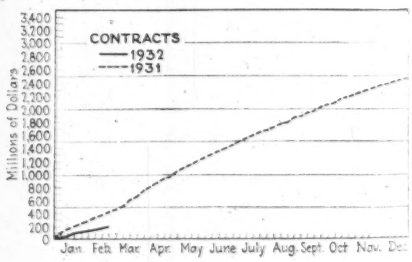
Capital and Contracts

New capital issued in the week ended March 5 totaled $15,000,000, compared with $14,000,000 in the preceding week and $146,000,000 in the corresponding week of 1931.

Public bonds accounted for $6,000,000 of the week's total, while private issues aggregated $9,000,000. In the preceding week the public and private totals were $12,000,000 and $2,000,000, respectively.

Cumulatively, the total for the period Jan. 1 to March 5, 1932, is $108,000,000, compared with $764,000,000 in the corresponding part of 1931.





Brief News

WATERWORKS OPERATORS are offered a short course in waterworks management at the Harvard Engineering School and the Massachusetts Institute of Technology during the week of June 6, sponsored by the New England Water Works Association, provided a sufficient number apply for admission. The course will consist of lectures, conferences, laboratory work and excursions, and the number of admissions is limited to 25.

CONSTRUCTION of a bridge across Raritan Bay between Staten Island, N. Y., and Monmouth County, N. J., although feasible from an engineering standpoint, would not be economically feasible, according to conclusions reached in an extensive survey conducted by the Port of New York Authority for Gov. Moore and the New Jersey legislature. The report states that present and anticipated traffic would not justify building the bridge.

VOTERS of Kittitas, Wash., on Feb. 22 favored a $30,000 bond issue for the construction of a municipal water system, and the city council plans to call for bids shortly.

A PAMPHLET, "Use and Care of Hoisting Chains" (Safe Practices Pamphlet No. 98), a compilation of experience in accident prevention, has been published by the National Safety Council, Inc., 20 North Wacker Drive, Chicago. It will be sent free on application.

Washington Notes

By Paul Wooton
Washington Correspondent

ACTION by the rules committee March 7 insures the consideration by the House of Representatives of the so-called levee setback bill, which transfers from local interests to the federal government the responsibility for compensating property owners for damages caused by the relocation of levee lines. Some weeks will elapse before a vote can be taken.

The bill had unanimous support in the flood-control committee, but faces strong opposition on the floor from those who will contend that this will add many millions of dollars to the ultimate cost of the project. Those favoring the measure will argue that the federal government assumed responsibility for flood control and should compensate for the use of property which is in the interest of the whole project as well as in the interest of the individual state in which the property is located.

Emergency Highway Bill

In the face of determined opposition from the administration uncertainty exists as to when the emergency highway construction bill can be brought before the Senate. The measure was reported favorably by the Senate committee on post offices and post roads. The item for forest development roads was increased from $3,000,000 to $5,000,000. An addition of $1,500,000 was made to the item for park roads.

The opposition to the measure will make it more difficult to to get it before the Senate, particularly as that body is behind in its consideration of the appropriation bills. There also is a possibility that some understanding may be reached between Senate leaders and executive officials. Even if that is found impossible, there is little doubt that the emergency bill can be passed in the Senate, but there would not be votes enough to pass it over a veto.

Regular Road Bill Help Up

Until the controversy over the emergency bill is settled, no effort will be made to bring the regular road authorization bill out of committee. The emergency bill carries a provision allowing any state that has arranged for completion and maintenance of 90 per cent of its federal-aid system to increase the per cent of federal-aid mileage from 7 to 8 per cent of the state system.

The Senate committee inserted in its bill a proviso that all contracts "shall contain provisions establishing minimum rates of wages to be predetermined by the state highway department, which contractors shall pay to skilled and unskilled labor; said minimum rates shall be stated in the invitation for bids and shall be included in proposals or bids for the work."

Another amendment by the Senate committee removes limitations on federal-aid construction within municipalities. It was felt that this would aid in relieving unemployment in cities and towns. The Senate committee has also stricken out of the House bill the requirement that the Federal government expenditure in no instance exceed $15,000 per mile.

Seek Revision of Freight Rates on Stone

Extensive revision of freight rates on building stone is expected to result from several cases now pending before the Interstate Commerce Commission. The rates in issue cover granite and marble, both in New England and the South, Indiana limestone, cast stone and other kinds of building stone, and embrace practically all territory east of the Rocky Mountains. The railroads have proposed adjustments in rates that would produce some additional revenue, but the principal feature is their desire to establish a differential between rough and finished stone.

SOCIETY CALENDAR

AMERICAN RAILWAY ENGINEERING ASSOCIATION, annual convention, Chicago, March 15-16.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Atlantic City, June 20-24.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Yellowstone National Park, July, date to be fixed.

AMERICAN WATER WORKS ASSOCIATION, annual convention, Memphis, Tenn., May 2-6.

AMERICAN WELDING SOCIETY, annual meeting, New York City, April 27-29.

NEW ENGLAND SEWAGE WORKS ASSOCIATION, annual meeting, Boston, April 25.

ARKANSAS ENGINEERS CLUB at its seventh annual convention in Little Rock, Feb. 26-27, elected as president W. W. Zass, construction engineer for the state highway department. Edgar T. Brown, Pine Bluff, was elected vice-president, and W. Terry Feild was reelected secretary-treasurer.

Personal Notes

CHARLES C. HOMMON, sanitary engineer in charge of the municipal sewage-treatment plant of Canton, Ohio, has been dismissed as a measure of economy.

ROBERT M. HOFFMANN, consulting engineer of the department of public works, Cleveland, Ohio, has been appointed city engineer to succeed George B. Sowers. This appointment is a consolidation of the two offices.

FRED L. BIECHELE, of Canton, Ohio, for the past ten years a deputy in the office of the surveyor of Stark County, has been appointed assistant to the division engineer of the Ohio state highway department, with headquarters at New Philadelphia. He succeeds Denn R. Sever, of New Philadelphia, resigned.

Obituary

GEORGE W. BOSCHKE, chief engineer of the Southern Pacific Railroad Co., died of pneumonia in San Francisco on March 3, age 67. Mr. Boschke joined the engineering staff of the Southern Pacific in 1886. Later he obtained leave to become chief engineer of the Oregon Railroad & Navigation Co. and left that line to supervise engineering work on the Galveston seawall. From 1914 to 1921 he had his own private engineering practice in Portland. In January, 1921, he was appointed assistant chief engineer of the Southern Pacific and in May, 1921, was made chief engineer. Some of the major construction projects during his service as chief engineer were the construction of the Cascade line from Klamath Falls to Eugene, Ore.; construction of new line through Phoenix, from Dome to Picacho, Ariz., and a new line from Klamath Falls, Ore., to Alturas, Calif.

EDWIN H. ROGERS, director of park engineering for the Metropolitan District Commission, of Boston, died of heart disease on March 6. Mr. Rogers was formerly chief engineer of the Boston & Worcester street railway and laid out and constructed nearly the whole of that railway's interurban system. In 1918 he was appointed city engineer of Newton, a position which he held for fifteen years. Mr. Rogers was a member of the American Society of Civil Engineers, the New England Water Works Association, the Massachusetts Highway Association and the Boston Society of Civil Engineers, of which he was a past-president.

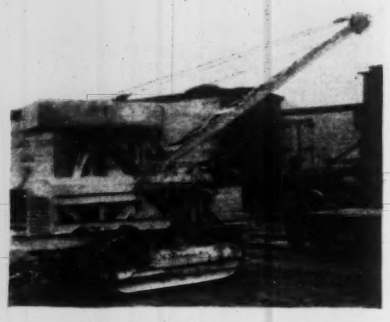
FREDERICK A. BAGG, of Millburn, N. J., of the engineering department of the New York Central R.R., died suddenly from heart disease on March 1, at the age of 61. Mr. Bagg was a graduate of Rensselaer Polytechnic Institute and was formerly chief engineer of the Johnstown, Fonda & Gloversville R.R. He made a preliminary engineering survey for the New York State barge canal.

FRANK M. LILLIE, formerly city engineer of Youngstown, Ohio, died on March 1 at the age of 77. Mr. Lillie, after his graduation from Oberlin College in 1880, first went with the Pittsburgh & Western Railroad and in 1891 was appointed assistant city engineer of Youngstown. Two years later he was made city engineer.

Construction Equipment and Materials

Full-Revolving Crane on Wide-Gage Tractor

A light-duty full-revolving crane, with a capacity of 5,000 lb. at 8-ft. radius, has been mounted on a wide-gage Caterpillar tractor by the Hughes-Keenan Co., Mansfield, Ohio. Power for swinging the boom is furnished by a multi-cylinder hydraulic motor, operating at a maximum pressure of 300 lb. per sq.in. from a hydraulic pump at the rear of the tractor. The standard boom is 12 ft. long and special lengths



Hydraulic controlled crane on wide-gage tractor.

of booms up to 18 ft. in length can be furnished. The load line is operated from another multi-cylinder hydraulic motor. The boom may be raised and lowered at will by power. All movements of hoisting and lowering are independently controlled, permitting simultaneous or alternate operation. The hydraulic control, unique in construction equipment, provides ideal operating characteristics. It permits holding a load at any point with safety and also the stopping of the boom at any desired point in the swing of the circle. Instead of a number of control levers, brakes and clutches, complete control is by two conveniently arranged control valves.

Anti-Friction Bearing Oil Seal

A seal that will hold not only grease but oil and that also keeps out grit, dirt and water in use with anti-friction bearings has been developed by the Aetna Ball Bearing Mfg. Co., Chicago. The seal consists of an outer shell of steel, accurately formed and ground on an outside diameter to a precision commensurate with that of anti-friction bearings, which houses a seal cushion, pressure plate and steel retainer. The seal cushion consists of specially treated cork in which the interstices or air cells are captivated and hermetically sealed, forming a pneumatic cushion automatically expanding and contracting with changing temperature of shaft or lubricant. The seal is available in sizes from ½ in. inside diameter and up.

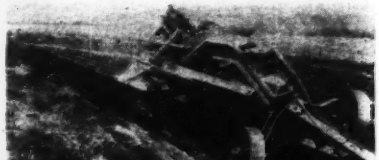
Cross-section of new-type oil seal.

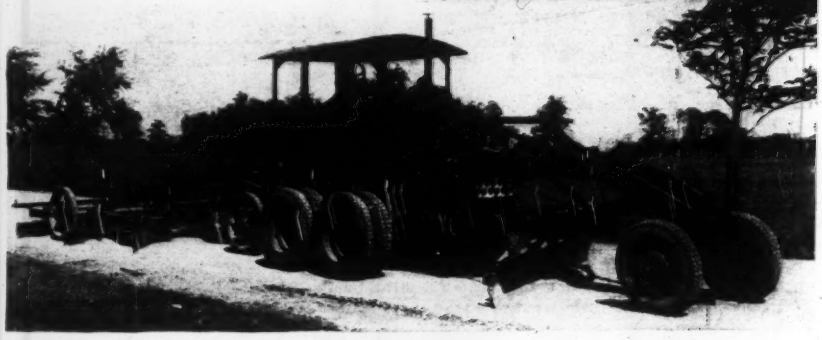
Austin Builds New Pulled Grader and Auto Maintainer

Two new pieces of road equipment have been developed by the Austin-Western Road Machinery Co., 400 North Michigan Ave., Chicago. The Austin motor grader, model 77, is regularly equipped with a 10-ft. blade and a six-cylinder motor, rated at 40 hp. The unit is equipped with the Austin dual drive, which provides absolute traction, freedom from miring and skidding, together with perfect steering. The machine is not built around a standard tractor but is of Austin design throughout. It can be equipped with scarifier, pneumatic or solid tires, or crawler treads, snow blade and snow plow, the blade bit for economical maintenance or the special double-deck moldboard for oil mix work. Although the accompanying illustration shows the motor grader pulling a four-wheel drag, the use of the drag is not necessary, though often desirable. The grader may be equipped with an interchangeable drag mounted on the circle, in addition to the blade.

The new Austin 101 grader is a heavy-duty pulled leaning wheel machine which embodies new and different features of design and construction. A new feature of the rig is the power leaning of the wheels, which greatly simplifies the operator's duties. The frame is of box shaped construction, consisting of two 12-in. channels, to which heavy top and bottom plates are continuously welded. The circle is a one-piece steel casting with blade arms welded in place. The grader is equipped with a blade 23 in. high having a 90-lb. railroad rail stiffener. Though heavy and rugged, the grader is handled with ease.

Austin's new leaning wheel grader (right) and new dual drive motor grader (below).





New Publications

Gravel Pit Machinery—Smith Engineering Works, Milwaukee, Wis., describes in Telsmith line of mining, quarry and gravel pit machinery in its new bulletin 2668.

Valves—Tilting disk valves, a type different from anything now on the market are described in a 10-p. bulletin issued by the Chapman Valve Mfg. Co., Indian Orchard, Mass. Both tilting disk check valves and stop valves are described.

Cork Products—"Jointite Cork Products" is the name of a new catalog published by Mundet Cork Corp., 450 Seventh Ave., New York City, which contains information on the uses of cork for insulation purposes, refrigeration, soundproofing, vibration deadening and condensation prevention, with charts and tables.

Water Softener—Softening water with Greensand Zeolite is described in a circular published by the Zeolite Chemical Co., 2 West St., New York City.

Incineration—The D-N Corp., Winston-Salem, N. C., has issued a 24-p. booklet on incineration for municipalities. Several types of incineration equipment as well as typical installations are described.

Air-Starting Units—Air-starting units for internal combustion engines are described in an 8-p. booklet issued by Ingersoll-Rand Co., 11 Broadway, New York City.

Paving Breakers—Ingersoll-Rand Co., 11 Broadway, New York, has issued a 20-p. catalog 4364 on paving breakers and pile drivers for sheetpiling.

Centrifugal Pumps—Catalog D-3 of the DeLaval Steam Turbine Co., Trenton, N. J., covers the DeLaval balanced single suction series pump. These units are a two-stage pump having single suction impellers placed back to back.

Uses of Expanded Metal—Industrial uses for Red Top expanded metal are described in a bulletin issued by the United States Gypsum Co., 300 West Adams St., Chicago.

Portable Air Compressors—A full line of portable air compressors and rock drills and tools is described in a booklet published by the O. K. Clutch & Machinery Co., Columbia, Pa.

Unit Heaters—St. Louis Blow Pipe & Heater Co., Inc., 1948 North Pine St., St. Louis, Mo., has published a 32-p. catalog describing the Skinner line of unit heaters.

Road Machinery—A pictorial bulletin of 24 pp. featuring the entire Austin-Western line of road machinery in action has just been published by the Austin-Western Road Machinery Co., 400 North Michigan Ave., Chicago.

Hoisting Engines—Lambert-National steam, electric and gasoline hoists are fully described in three attractive bulletins known as catalogs 42, 43 and 44, respectively, published by the McKiernan-Terry Corp., 15 Park Row, New York City. Piledrivers, pile sawing machines, floating derricks and land derricks are included in the book on steam hoists. Each booklet describes many installations of the various hoists and also includes several tables and data pertinent to hoisting work.